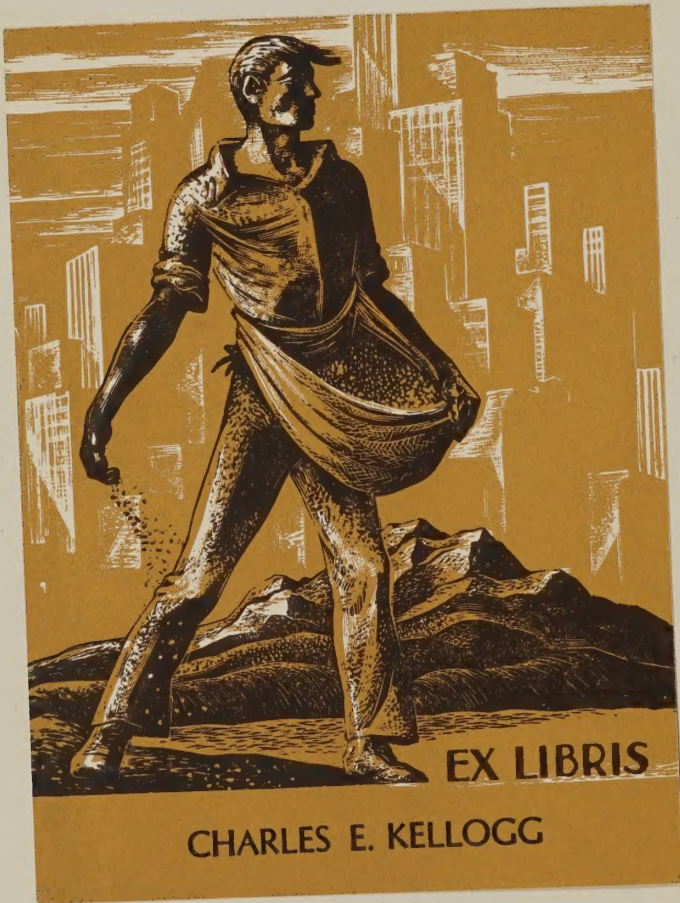
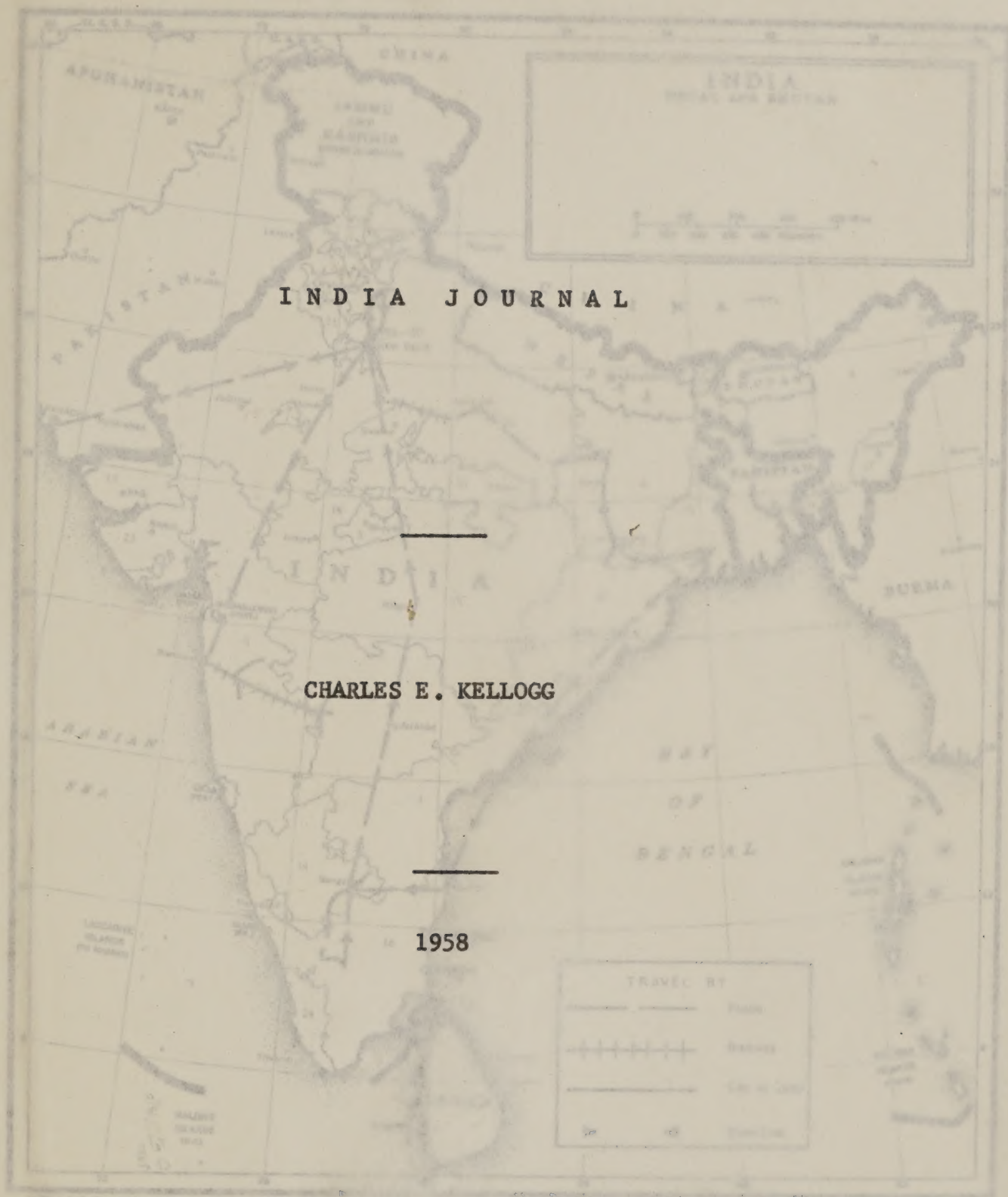




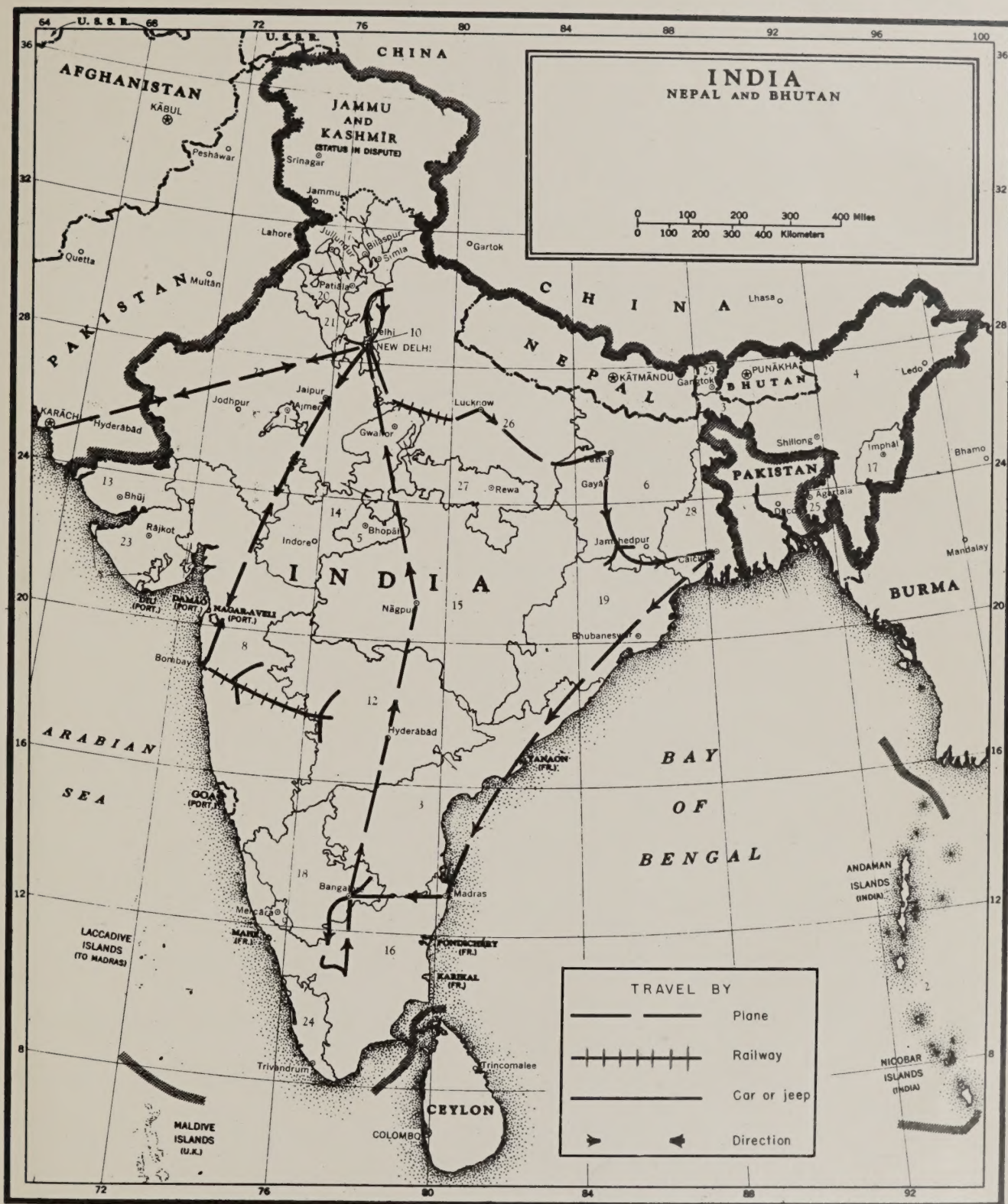


1:100,000 Scale Sheet Number 10555

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- International boundary
- State boundary
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- State capital



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14. MADHYA BHARAT
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18. MYSORE
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20. PATIALA AND EAST PUNJAB STATES UNION (PEPSU)
21. PUNJAB
22. RAJASTHAN
23. SAURASHTRA
24. TRAVANCORE-COCHIN
25. TRIPURA
26. UTTAR PRADESH
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29. SIKKIM (protectorate)

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II.

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INDIA JOURNAL

1958

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During the autumn of 1957 arrangements were made with the Rockefeller Foundation for the travel to start January 1, 1958 and to end February 11, 1958 and to include a one-day stopover in Rome (FAO) on the return trip.

This Journal is a record of my notes taken on the spot, nearly always in great haste. Some of the observations and opinions noted may be in error. This Journal is not to be quoted except with permission in writing.

No attempt has been made to include summaries of all my many speeches and discussions, although the general tone of them is consistent with the report presented to the Government of India. Besides the black-and-white photographs, a small group of colored transparencies is on file.

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M. Lal, I.C.S.
Joint Secretary.

No. 15-14/55-SC
GOVERNMENT OF INDIA
MINISTRY OF FOOD AND AGRICULTURE
(Department of Agriculture)

..

New Delhi
Dated the 12th August, 1957

Dear Dr. Cummings,

Please refer to your letter of the 11th July, 1957 to Dr. Uppal, regarding the possibility of Dr. C.E. Kellogg coming to India for a short period for consultation. I write to confirm that we shall be grateful if the Rockefeller Foundation could arrange to send Dr. Kellogg for a period of 4 to 6 weeks after January, 1958 to advise the Central Soil Conservation Board on:-

- (i) the organization, planning and execution of Soil Survey in the country.
- (ii) the development of State and Centre cooperation and participation for developing and utilising soil survey information.
- (iii) technique and operational procedure in survey work.
- (iv) staff requirements for survey and training of personnel.
- (v) utilisation of survey information in constructive planning and development program.
- (vi) utilisation of the National Soil Survey in relation to soil conservation program on the one hand and soil and agronomic research program on the other.
- (vii) the integrated survey program to be developed in addition to providing a basis for a comprehensive classification and inventory of soil resources of the National should provide a foundation of:
 - (a) The Soil information needed for the planning and development of the agricultural phases of irrigation projects.
 - (b) The Soil information needed by the technicians and cultivators for developing proper use and treatment

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 - (a) The Soil information needed for the planning and development of the agricultural phases of irrigation projects.
 - (b) The Soil information needed by the technicians and cultivators for developing proper use and treatment

of the cultivators land for soil and water conservation and agricultural production.

- (c) The Soil information needed in the river basins planning and development.
- (d) Soil survey information that may be needed by States.

The assignment of Dr. Kellog, we hope, will be governed by the terms and conditions laid down in "Memorandum of Understanding" already entered into by the Government of India with the Rockefeller Foundation on the 12th April, 1956, relating to the Agricultural program of this country.

I shall be grateful for an early confirmation.

Yours sincerely,

(M. Lal)

Dr. Ralph W. Cummings
Filed Director
Indian Agricultural Program
The Rockefeller Foundation
Suit 107 Asoka Hotel
New Delhi

Copy forwarded for information and necessary action to:

1. The Embassy of India in U.S.A., Washington
2. Department of Economic Affairs, Ministry of Finance,
(Shri C.L. Garg) Under Secretary, New Delhi.
3. Soil Conservation (Instt.) Section.

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R.N. Sena

January 1: Mrs. Kellogg drives me to the station and I leave on the Pennsylvania train for New York City at 8:45 a.m. I have some feeling of misgiving to start another long trip with a sore back and threatened ulcers, but there seems to be no help for it. I leave New York City at 12:40 p.m. and go to the East Side air station. I take the bus to the air field and the plane leaves for Europe about 5:00 p.m. Out over the Atlantic one day changes to another.

January 2: My plane is down in Paris for an hour and a half and we leave for Rome at 11:30 a.m.

Clouds cover the Rhone Valley but I have a beautiful view of the French Alps, including Mt. Blanc and the mountains north of Nice. Later I get a glimpse of Corsica but clouds cover most of the land later on.

We are down at Rome at 2:15 p.m. Dr. and Mrs. Ignatieff meet me at the airport and we have tea and a nice chat. I make my plans to see them on my way back. Dr. Ignatieff tells me that the Agriculture Division of FAO is to be broken up into several divisions. Previously I had called his attention to the need for editions in Spanish of material on soil conservation, which I thought should be sponsored by FAO. He suggests that there may be some possibility that the Conservation Foundation in New York would put up the money. I agree with this provided the Soil Conservation Service and FAO have technical control over the material.

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My plane leaves again about 5:30 p.m. I have only glimpses of land beneath the clouds. It is soon dark and we are served dinner. The time goes slowly.

We are down in Beirut about 9:20 p.m. I have quite a wait in the air station while one day changes to another.

During the long wait in Beirut I meet a Mr. and Mrs. Harrington. He tells me that he sells buses and trucks and was once a special adviser with the State Department during the partition of India and Pakistan. He seems much more favorable to the Pakistanians than to the Indians.

While we are waiting in a separate room an enthusiastic crowd welcomes the former Prime Minister of Lebanon, who is now a leader of the opposition.

January 3: My plane leaves Beirut at 12:30 a.m., and I go to bed.

I sleep for 5 hours and get up for breakfast. We arrive at Karachi, Pakistan at 9:40 a.m. Although I am only changing planes here we have to go through the formalities of the customs.

The Pan American people are very helpful and I check in with the Indian Air Corporation for the flight to Delhi.

I have quite a long wait here. The Karachi airport is very large with nice shops to spend money for rugs and other articles at almost New York prices. One of the Pakistan shopkeepers tries to entice me into his place but I tell him I can buy nothing now.

Dark now. My head hurts. Dark.

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He asks me where I am going and I tell him. He says, "Are you sure that the Indians are sincere in wanting you to come? You know they are not two-faced, but four-faced."

I get on a small plane and we are in the air at 2:16 p.m. (which is 2:46 p.m. Delhi time). Very soon we are over a landscape that is very close to desert. The land is nearly barren with many gullies on the highlands. Then we are over some nearly level plains, bordered by gently sloping fans. The plain is dissected near the main stream channels. Some parts of it have a cover of low shrubs. I see sand in the distance and a few habitations. The landscape looks a bit like the Sahara. About 30 minutes out we cross a large muddy stream in this dry plain.

After lunch (and about three-quarters of an hour out) we are over irrigated farming areas with small, square fields. Some are gray, some brown, and some green. Parts of this large nearly flat, delta plain appear to be salty.

A little later we cross a canal and are back in semi-desert, which has a little dry farming. Now there are numerous small ponds that appear to be salty. As we go on some of this semi-desert is sown and part seems to have been abandoned.

About 5:25 p.m. it becomes nearly dark and the soil seems to be reddish brown. Most of the fields are about 5 to 15 acres in size. Below a low scarp a few scattered fields are green, suggesting local irrigation. Dimly I see barren, eroded low mountains to the southeast.

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Dark now. My head aches. Dark.

We are down in the Delhi airport at 6:42 Delhi time. Several people have come to meet me at the plane including Dr. and Mrs. Ralph Cummings, Dr. and Mrs. Frank Parker, Miss Louise Clause, Mr. W. M. Nixon, Dr. Lyman Dean, Mr. and Mrs. J. B. Davis, Dr. J. K. Basu, Dr. S. P. Raychaudhari, Dr. R. V. Tamhane, and Mr. Anand.

I go through the formalities of customs rather rapidly and am too tired for a social dinner. I am driven at once to the Ashoka Hotel. I have tea brought to my room and have a brief talk with Dr. Cummings about my program; then a wire to the office; letters home; and to bed.

January 4: This seems to be a nice hotel. I note they have 30-minute pressing service. Tea with an apple is brought quickly by the bearer.

After breakfast I have a conference with Dr. Cummings in his office, conveniently located in the hotel, and discuss my program with his assistant director, Dr. U. J. Grant, and Dr. Basu, a Director of Soil Conservation. This seems to take a good deal of talking about endless details. We decide to cut out one planned trip to the North to see a dam so that I may have a little time between the other trips to start the preparation of my report for the Government of India.

Dr. Cummings tells me there are 200 million cattle in India of which 40 million are buffalos.

We are down in the Delhi airport at 6:45 Delhi time.

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Dr. Cummings takes down all the notes about the field trips and plans to work up a copy for me. It seems I shall need to have anti-malaria medicine, a water bottle to carry, and a bedroll. Dr. Basu had insisted that I would need a bedroll; but Cummings explains that the Indian professional people have a very low allowance for travel, about \$1.75 per day, so they don't stay at the best hotels. No wonder so many of them are vegetarians! Although Dr. Cummings says many Indians eat meat, except for beef, when they can get it.

I am told that it is to be announced soon that Dr. S. P. Raychaudhari of the Indian Agricultural Research Institute will be in charge of the Soil Survey. Unhappily, most of his experience has been in the laboratory and not much in the field. Possibly the decision to have the Soil Survey in the IARI (Indian Agricultural Research Institute) is not a final one and that some arrangements can be made to adjust priorities in a way to be sure to have the soil surveys ahead of the soil conservation planning.

After lunch I go to exchange some money at the bank and find that the exchange rate is lower on money than on traveler's checks. Then I look at the little hotel shops, which are very expensive. They show me emeralds and solid gold elephants along with Kashmir rugs. So far my sales resistance is holding up.

Dr. V. J. Grant, Rockefeller Foundation

Dr. K. O. Rachie, Rockefeller Foundation

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At 5:00 p.m. I go to a reception tea arranged by Dr. Cummings so that I may meet several of the people with whom I will be working. The list follows:

Mr. D. A. R. Bhadran, Deputy Secretary, Forests
Dr. Charles E. Kellogg
Dr. B. N. Uppal, Agricultural Commissioner, ICAR
Dr. J. K. Basu, Director, Soil Conservation (Agronomy and Soils)
Dr. S. P. Raychaudhuri, Head, Division of Chemistry & Soil Science
Indian Agricultural Research Institute
Dr. B. P. Pal, Director, IARI
Dr. R. V. Tamhane, IARI
Dr. F. W. Parker, Chief Agriculturist, TCM
Mr. U. S. Madan, Director, Soil Conservation (Forests)
Dr. L. A. Dean, TCM
Mr. G. G. Tackle, Inspector General, Forests
Mr. M. S. V. Rama Rao, Director Soil Conservation (Engineering)
Mr. T. C. Puri, Joint Secretary, Ministry of Food & Agriculture
Mr. T. S. Krishnamurti, Deputy Secretary, Soil Conservation
Dr. R. W. Cummings, Rockefeller Foundation
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I am much impressed by the Secretary, who is the top administrative officer of the Ministry of Agriculture. He tells me at dinner how much easier it is to get young people to adopt new houses and new ways of living than old people. The older people don't like the new houses. They are afraid that people will break in through the windows and steal. They are afraid that their enemies will throw burning oil rags through the ventilators. And they don't like narrow doors since they are too narrow for the old dowry trunks, even though the new houses have ample cupboard space. The old people don't like high stoves. The old women say they will need to hold their grandchildren on their laps while they cook, so they prefer the low stoves.

He speaks a bit about too many cows in India.

We speak a little about the USSR. He is not friendly toward the Russians and he knows of the harm done to agricultural research in Russia by Lysenko.

Late to bed and late to sleep.

After the morning tour I return to the hotel and have tea, milk, and cakes in my room.

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January 5: (Sunday) Fortunately I sleep a little late. After breakfast I have a short tour of the city with Mrs. Cummings and Dorothy Parker. We first go to the Jama Mosque (of the 17th century) in old Delhi. The Mosque is poorly kept. Around the mosque many poor people "squat" in very crude shelters, very close together. They appear to be either on temple or city land.

There are many cows in the street but not so many as I had expected. In the gardens I see bougainvillaea, cannas, dahlias, roses, marigolds, and many other annual flowers. Many of the trees resemble the mesquite in Texas.

We stop in a jewelry shop. Prices seem to be reasonable but one never knows for sure.

We drive up to the Red Fort but it is closed today. Then Mrs. Cummings takes up to the Ghandi Memorial. Here we have to check our shoes. This memorial is a very simple one, low, and sets in a large park with much lawn and a few flowers. Apparently the cows are kept out.

The Government buildings and the President's palace are very well designed, as a modern adaptation of the old style. I am told these buildings were designed by the British and constructed about 1930 from red sandstone.

After the morning tour I return to the hotel and have tea, milk, and cakes in my room.

January 2: (Sunday) Fortunately I sleep a little later. After breakfast I have a short tour of the city with Mrs. Cummings and Dorothy Parker. We first go to the Jama Mosque (of the 17th century) in old Delhi. The Mosque is poorly kept. Around the mosque many poor people "squat" in very crude shelters, very close together. They appear to be either on temple or city land. There are many cows in the street but not so many as I had expected. In the gardens I see bougainvilleas, cannas, dahlias, roses, marigolds, and many other annual flowers. Many of the trees resemble the mesquite in Texas. We stop in a jewelry shop. Prices seem to be reasonable but one never knows for sure. We drive up to the Red Fort but it is closed today. Then Mrs. Cummings takes up to the Gandhi Memorial. Here we have to check our shoes. This memorial is a very simple one, low, and sets in a large park with much lawn and a few flowers. Apparently the cows are kept out. The Government buildings and the President's palace are very well designed, as a modern adaptation of the old style. I am told these buildings were designed by the British and constructed about 1930 from red sandstone. After the morning tour I return to the hotel and have tea, milk, and cakes in my room.

At 1:20 p.m. I go out with Dr. Dean, Dr. Parker, and Dr. Kalumkar of the Indian Council of Agricultural Research. We drive over to pick up Dr. Kalumkar in a new, beautiful subdivision. They have planted hedges of *Sesbania Egyptiaca*. This is a legume, which, I am told, is used also as a green manure.

Delhi is on the margin between the dry area to the west and the humid area to the east. We drive west into the dry area. The cultivated soils are reddish-brown and remind me of dry parts of Oklahoma and of Texas west of the Cross Timbers. It is bright and sunny; warm, but not hot.

Driving here is a game. There are a great many bicycles on the street and many pedestrians. I see little donkeys with huge saddle baskets carrying earth and bricks along the road. There are several brick-making establishments. Only a small part of the soil is under irrigation. We pass ruins of small buildings that are said to be very old and to represent the location of Delhi during the 13th century.

We stop to see Qutab Minar Tower, built in the 12th century. It is quite impressive. I try photographs of the old Hindu columns of 1100 A.D., and of the great iron pillar, said to have been cast at Orissa between 300 and 500 A.D. Legend has it that if one can stand with his back against the iron tower and reach all the way around it he is destined for good luck. Certainly anyone who can do this is free of arthritis in the back! Many people are visiting this area, which has room for family picnics.

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As we drive on west I see many ruins of old buildings scattered about, with small fields among them. Some have crops of mustard and I also see gram (chickpeas). Mangoes and other trees have brick, iron, or stone cylinders built around them to protect them from cattle. Further on I see pigeon peas (or ahar). We pass some very old tombs of Sultan Gari of the 12th century or thereabouts. We pass a low stony ridge with many excavations made by quarrying rock and by people carrying away the loose earth. I see an old dam that has been silted to the top. Here it is common to grow wheat mixed with mustard.

Most of the young trees in Delhi and along the roads are protected by gratings or cylindrical brick open work. These are from 3 to 5 feet high. Some of the brick ones are topped with mud or cement. Of course, such protection is necessary in this area to have any trees with cows running about freely.

We drive west on nearly flat soil and I see quite a bit of idle land here that needs only a little land-forming to be arable.

We stop to look at wheat that is now about 6 inches high on yellowish-brown fine sandy loam. Dr. Dean estimates the yield will be about 15 bushel to the acre. This seems low. The soil has an excellent structure, but needs irrigation, fertilization with phosphorus and nitrogen, and better weed control. Many of the irrigated areas are salty. This soil is from old alluvium and is said to have about 2 to 5 percent calcium carbonate and a pH of from 8 to 8.5.

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K-2388 Jan. 5, 1958. West of Delhi. Typical cattle guard for trees.



K-2383 Jan. 5, 1958. West of New Delhi. Qutab Minar tower (12th century).

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K-2388 Jan. 5, 1958. West of New Delhi. (12th century).
The middle ground is typical of the 12th century.



K-2384. Jan. 5, 1958. West of New Delhi. Old Hindu columns at Qutab Minar tower.



K-2385. Jan. 5, 1958. West of New Delhi. Old Hindu columns at Qutab Minar tower. (Another view.)

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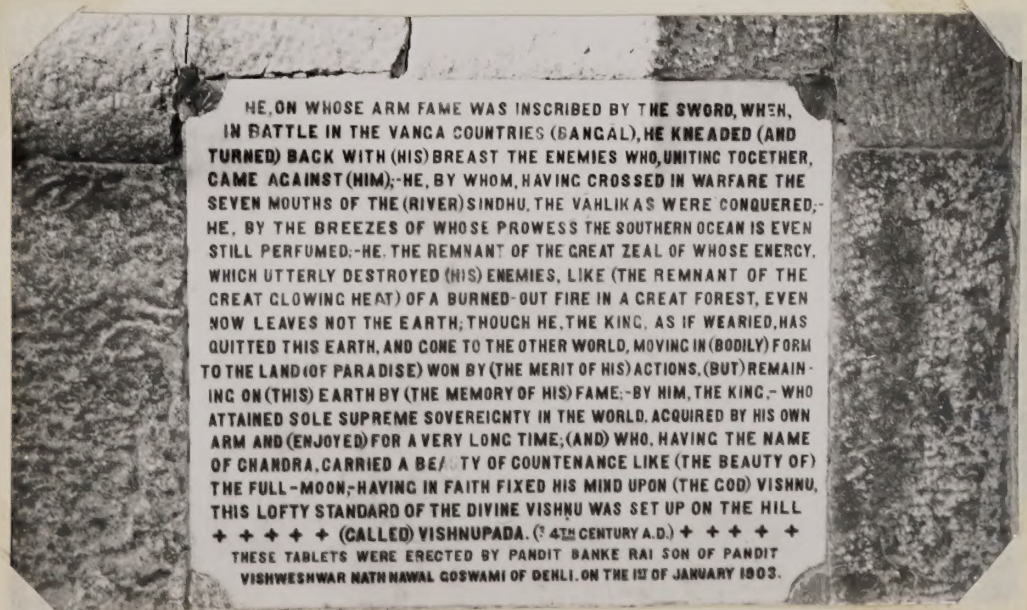
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K-2386. Jan. 5, 1958. West of New Delhi. Iron pillar at Qutab Minar, cast at Orissa about 300 to 500 A.D.



K-2387. Jan. 5, 1958. West of Delhi. Translation of inscription on iron pillar at Qutab Minar.

K-2386. Jan. 5, 1958. West of New Delhi. Iron pillar
at Gushab Minar, east of Gushab about 300 to 500 A.D.

K-2387. Jan. 5, 1958. West of Delhi. Translation of inscription
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K-2389. Jan. 5, 1958. Between Delhi and Guragon. Deepening of old stream channel in fine sandy alluvium. The accelerated side gullies resemble those in the Memphis and Marshall soils of the United States.



K-2390. Jan. 5, 1958. West of Delhi. View at Tughlakabad. An emperor of the 14th century built his tomb in a lake, which has since been filled with silt.



K-2391. Jan. 5, 1958. West of Delhi. A characteristic home near the road.



K-2392. Jan. 5, 1958. West of Delhi. A food seller near the road.

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- 12 -

We pass Gurgaon, a district headquarters, and then turn back to Delhi. Even some areas of this good soil from alluvium are idle. Part of these are village commons. I am surprised that farming does not come nearer to the roads in this food-deficient region.

We cross a very deep old natural channel cut into this fine sandy alluvium with bad gullies working back into the soil. The

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K-2393. Jan. 5, 1958. West of Delhi.
An old Persian type well.

On the way back to Delhi we have a long, long wait at a gate by the railroad although no train is in sight. I am told that here in India the gates are closed long in advance of the train. By the side of us is a large herd of buffalo that look up to be in quite good flesh.

We are back in Delhi at 3:30 p.m. and have tea with Dr. Kalisher. His daughter gives me a painted ash tray. In the evening I have dinner with Parker. Mrs. Parker is still not entirely well.

An old Persian type well.
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We cross a very deep old natural channel cut into this fine sandy alluvium with bad gullies working back into the soil. The alluvium appears to be almost identical with loess and the gullies look like those in western Iowa.

Near here I watch a peasant woman making cakes out of cow dung and laying them out to dry for fuel. We stop briefly at Tughlakabad, which was the headquarters of the Emperor in the 14th century. He made his tomb in a lake with causeways out to it. Now the lake has become full of silt and most of the arches of the causeways are out of sight.

How little human labor is worth here! One sees men and women making gravel for the roads by breaking quartzite by hand with a hammer.

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He gives me some background of the soil survey program. It doesn't look very good. Most of the people are trained in chemistry and there are very few field scientists. So far there is no plan to have the survey work where it is most needed. Plans have been made for a large cartographic unit, which is not yet required, nor have they the people to operate the expensive equipment that has already been delivered. I was afraid of all this; but all I can do is my best, which may not be good enough.

Dr. Parker suggests I talk especially with Dr. Agarwal in Kanpur about Center-State relationships.

I am back to the hotel at 10:30 p.m., very tired after my first "rest" day.

January 6: I slept a bit late this morning because I had trouble going to sleep. Apparently I must not drink so much strong tea in the evening.

After breakfast I go again to Dr. Cumming's office. He explains to me that the Indian Council of Agricultural Research is a fund-granting body. The funds come mainly from export licenses. The Council reacts to schemes submitted to it and sets up some schemes on its own initiative.

The Indian Agricultural Research Institute is a central institute somewhat like our Beltsville. It has a staff and budget provided by the Ministry of Agriculture. But some of its work is

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Dr. Cummings and I called on Dr. Acharya, who is in charge of the Indian office of FAO. He emphasized the need for a cheaper Indian edition of the new edition of Efficient use of fertilizers. He said that if many Indian students read it the price should be at the most 4 rupees.

Dr. Acharya thinks the Government of India should take more active means for birth control clinics and other ways of cutting down on the increase in population. He thinks that many of the Indians are lazy. The way things are going now, India^{will}/need to import food for at least 25 years. He says the Government is trying hard to make India self-sufficient, and he believes that to be wrong. He says that the lack of food is not due to a rise in economy. Formerly poor cultivators lived on about 100 to 1200 calories per person, whereas they now have about 1850 to 1900 calories.

He says the British spent a high proportion of their money near Delhi and in Kashmir since the bulk of the army was in those two place. Elsewhere there was less need for protection.

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(Added later: I see subsequently that the salty areas near the canals are due partly to wide, shallow borrow strips, not entirely or even mainly to seepage.)

Dr. Cummings and I go to Dr. Parker's office in the ministry of Food and Agriculture to prepare for the conferences with the ministers, especially Dr. P. S. Deshmukh, Minister for cooperation and Mr. A. P. Jain, Minister for Food and Agriculture. Mr. Deshmukh is chairman of the Soil Conservation Board. When I see him he talks about what I need to see in the field. We have a general discussion of the problems and the importance of combining practices for water control and for fertilization in order to increase the food supply. I talk a bit with Mr. Jain and his staff. I discuss the need of helping the cultivators to make decisions for themselves rather than making them for them. I emphasize that the so-called conservatism of rural people is not really conservatism in the ordinary sense, but rather indicates their inability to take risks, especially when they are poor and have few resources.

Following this brief and general discussion Dr. Cummings takes me to the American Embassy where I register and have a brief talk with a Mr. Chapman - a young geographer from Ohio University, who is in charge of collecting as many maps of India as possible. He tells me that so far the Indians are very communicative about coverage of the country with air photos and future plans for photography. He says that so far requests for air photos for soil mapping have been refused. (Added later: Mr. Chapman is a young and inexperienced man for this assignment, and after meeting

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young and inexperienced man for this assignment, and after meeting

the Surveyor General of India I can understand why he did not get very far.)

I return to the hotel for lunch and then go to the Indian Agricultural Research Institute. I am met and shown about by Dr. Raychaudhuri, Chief of the Chemical Section and slated to be the Director of the Soil Survey.

In the library there are many periodicals, mostly in English, but I am told they have others in French. People are not allowed in the library stacks and I note that all the books are back of padlocked iron and glass doors.

I call on Dr. R. D. Asana, Head of the Botany Division. He shows me some interesting work in genetics.

We then look at the chemistry office and laboratories. Dr. Parker had told Dr. Raychaudhuri about my interest in early agriculture of ancient India. He tells me he has a book on this subject in press.

The physical chemical laboratory strikes me as being very dirty, but they have new apparatus for differential thermal analyses and a Beckman colorimeter. Dr. Raychaudhuri tells me they will soon have an electron microscope (which they need like a hole in the head!).

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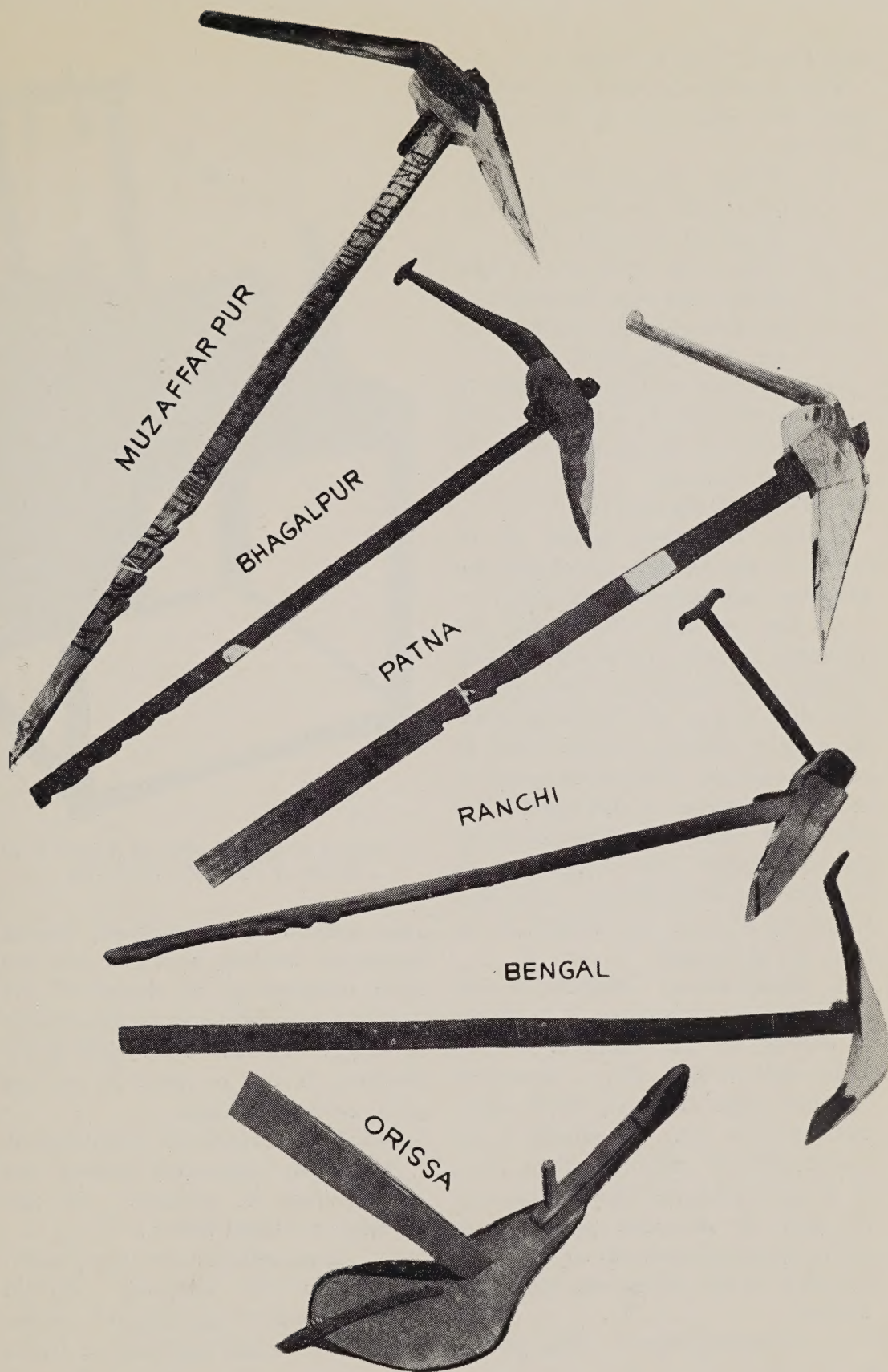
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*Part of the collection of indigenous ploughs in the Division of Agricultural Engineering.
Such collections afford valuable material for study*

SET-UP OF THE DIVISION

The Division comprises four sections with the following as their main activity :—

1. Testing of agricultural implements and machines including laboratory and field tests.
2. Design and fabrication of new implements and machines.
3. Land development, land drainage and irrigation.
4. Servicing and maintenance of experimental machinery and plants of the other Divisions of the Institute.

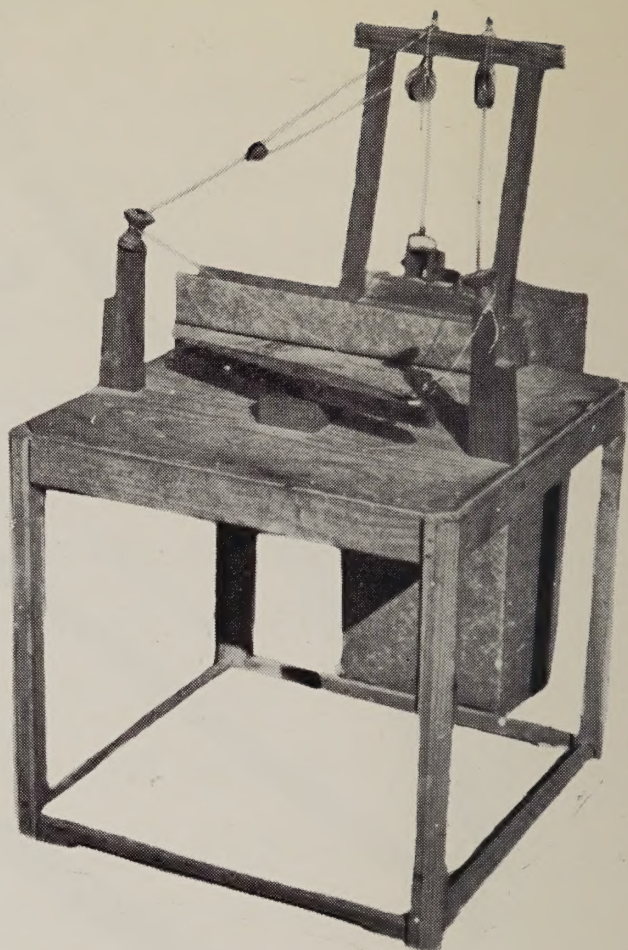
IMPORTANT RESULTS

During the short period of its existence, the Division developed the following implements and machines :—

1. *Jute seed-drill*: Agronomic experiments carried out by the Indian Central Jute Committee have shown that yield of jute are increased when the crop is drilled in rows instead of being broadcast. It therefore appeared necessary to design a drill suitable for sowing jute seeds. At the request of the Indian Central Jute Committee, a four-row bullock-drawn seed-drill which can sow one acre of land in an hour was developed.

2. *Rotary Screen*: Millions of tons of good compost manure is available in dumps on the outskirts of big cities and towns. But unwanted elements, such as bricks, stones, glass pieces and tin cans, are usually found mixed with the material; these have to be removed before the compost can be used for manurial purposes. A rotary hand-operated screen has been designed which sieves out the good manure.

3. *Groundnut planter*: This single-



A model of an improved water lift designed in the Division of Agricultural Engineering

row bullock-drawn machine, having automatic seeding arrangements has been designed at the request of the Indian Central Oilseeds Committee for sowing groundnut. With slight modifications, it can be used for sowing peas, beans and maize.

INVESTIGATIONS IN PROGRESS

The most important among the investigations in progress in this Division are listed below:

1. Investigations into the possibility of adapting certain Japanese agricultural implements and machines in India.

I am introduced to Mr. L. M. Mathur, who spent some time in Beltsville and is in charge of the Cartographic Laboratory for the Soil Survey. Through the TCM, they have a very fine copy camera that cost about \$20,000, a large press, and other equipment. They do not have the space for this equipment nor do I believe they would be able to use it. I certainly hope that arrangements can be made to get the work done at the Survey of India.

Dr. N. P. Datta, gives me a brief explanation of the radio-activity tracer work with which Dr. Lyman Dean has been concerned. I have a quick look at the soil-testing laboratory with Dr. Tamahne. Then we go to Dr. Raychaudhuri's office for tea.

Following the tea I give a lecture to the whole group on soil conservation and soil management. This is an adaptation of similar speeches given in the United States around the concept of the ideal soil and how to maintain it. The speech seems to go over very well.

This evening I have dinner chez Engle. Dr. Parker had told me that they were very keen on jewelry. Mrs. Engle has a lovely collection of jeweled rings. They also have a lot of very nice brass and copper. After dinner a local jeweler, Moti, comes in and shows me his things. I pick out an Indian princess ring for my wife. I have a little trouble convincing the jeweler that I want it very small. I finally explain to him that I had lived with my wife for sometime and knew she had a very small finger.

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I also picked out a large topaz pendant and two small matching stones for ear clips.

Back to the hotel a little after 10. I note that the room is carefully cleaned by hand with a small brush on the rug and with a wet cloth for the rest of the floor. I always have cut flowers on the table. And each room has an electric refrigerator, in my case for cooling boiled water, but I suppose it also has other uses.

January 7: For some reason I have no sleep after 4:00 a.m. I go to breakfast with a sort of dull headache.

After a little time in Dr. Cummings' office I go to the office of Dr. B. N. Uppal, Agricultural Commissioner of the Indian Council of Agricultural Research. I then attend a formal meeting of the technical subcommittee on Soil Survey, including the following:

Dr. J. K. Basu, Director, Soil Conservation, Chairman

Mr. U. S. Madan, Director, Soil Conservation, Forestry

Mr. M. S. V. Rama Rao, Director, Soil Conservation, Engineering

Dr. S. P. Raychaudhuri, Chief Soil Survey Officer

Mr. R. C. Hoon, representing Ministry of Water and Power

Mr. Nixon, TCM

Mr. T. J. Mirchandani, Agronomist, Indian Council of Agricultural
Research

Mr. Aggarwal, Agricultural Chemist, State of Kanpur (not present)

Mr. A. D. Desai, Bangalore

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Mr. M. S. V. Rama Rao, Director, Soil Conservation, Engineering

Dr. S. P. Raychaudhuri, Chief Soil Survey Officer

Mr. R. C. Hoon, representing Ministry of Water and Power

Mr. Nixon, TCM

Mr. T. J. Michandani, Agronomist, Indian Council of Agricultural Research

Mr. Aggarwal, Agricultural Chemist, State of Kanpur (not present)

Mr. A. D. Desai, Bangalore

Dr. Basu gives a lecture on the general situation in India. He rather oversimplifies by grouping all the land under three headings as (1) agricultural land, (2) desert land, and (3) hill land. He emphasizes that they have four groups of agricultural soils: (1) Black soils with 20 to 40 inches of rainfall, undulating topography, and very poor permeability; (2) laterite soils with 100 to 200 inches of rainfall, rolling, and poor permeability; (3) red soils with 60 to 150 inches of rainfall, rolling, and fair permeability; and (4) alluvial soils with 20 to 150 inches of rainfall, flat, and good permeability. He says that the black soils have the highest erodibility. It is high on gentle slopes of laterite soils and of red soils and low on the "alluvial" soils. (Added later: I discover later that this was too general to be useful. A great many of the actual soils are intergrades. For example, much of the black soil shown on the map is really an intergrade between black soil and something like Reddish Chestnut).

He says there are 90 thousand square miles of desert having high temperatures and high winds. The soils are developed from sediments of trap rock and granite. Cultivation is recommended only where the rainfall is over 10 inches. At about 10 inches shelterbelts of trees are suggested and grasses for grazing below 10 inches. He says many of the grazers have no land of their own and drive their stock anywhere. There is an attempt now to guard the ranges by fencing, but this is very expensive.

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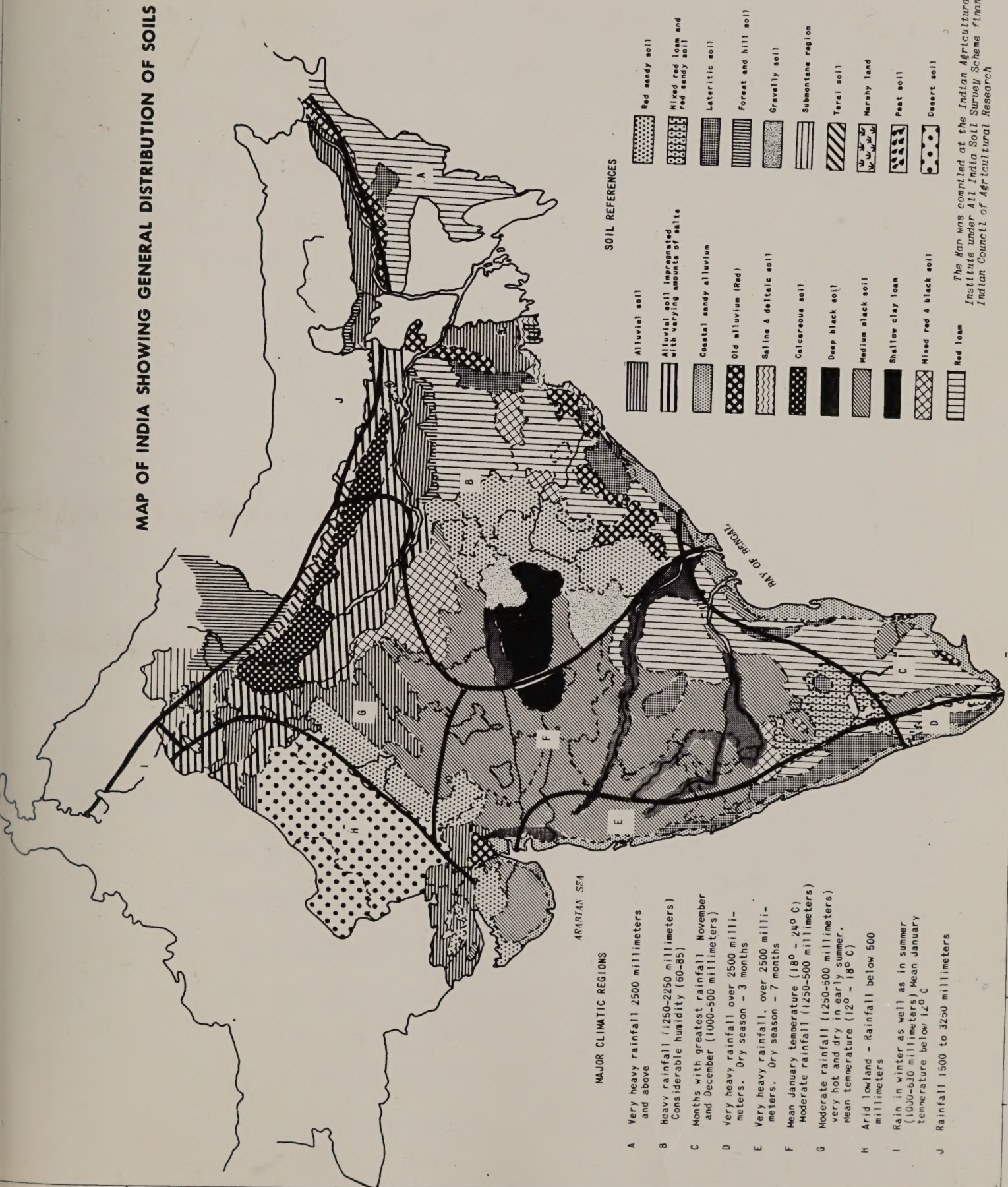
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MAP OF INDIA SHOWING GENERAL DISTRIBUTION OF SOILS



ARABIAN SEA

MAJOR CLIMATIC REGIONS

- A Very heavy rainfall 2500 millimeters and above
- B Heavy rainfall (1250-2250 millimeters)
- C Considerable humidity (60-85)
- D Months with greatest rainfall November and December (1000-500 millimeters)
- E Very heavy rainfall over 2500 millimeters. Dry season - 3 months
- F Very heavy rainfall, over 2500 millimeters. Dry season - 7 months
- G Mean January temperature (18° - 24° C) Moderate rainfall (1250-500 millimeters)
- H Moderate rainfall (1250-500 millimeters) very hot and dry in early summer. Mean temperature (12° - 18° C)
- I Arid lowland - Rainfall below 500 millimeters
- J Rain in winter as well as in summer (1000-630 millimeters) Mean January temperature below 12° C
- K Rainfall 1500 to 3250 millimeters

SOIL REFERENCES

- Alluvial soil
- Alluvial soil impregnated with varying amounts of salts
- Coastal sandy alluvium
- Old alluvium (Red)
- Saline & deltaic soil
- Calcareous soil
- Deep black soil
- Medium black soil
- Shallow clay loam
- Mixed red & black soil
- Red loam
- Red sandy soil
- Mixed red loam and red sandy soil
- Lateritic soil
- Forest and hill soil
- Gravelly soil
- Submontane region
- Teral soil
- Marshy land
- Peat soil
- Desert soil

The Map was compiled at the Indian Agricultural Research Institute under All India Soil Survey Scheme financed by the Indian Council of Agricultural Research

Dr. Basu says in the hilly regions there is high erosion following overgrazing and overcutting. Some areas are used 2 years for crops, then rejuvenated with 5 to 7 years of bush fallow. Some slopes are of sandstone and there are many sand torrents that cover the good lower soils. In this area landslide problems are serious.

From the discussion I gather there is a total of 50 million rupees for 5 years for soil conservation. Of this, 4 million is to be used for research and training; 1 and 1/2 million for soil survey, and the remainder for grants to State governments for soil conservation work.

Dr. Basu concludes and we have another speech by Dr. Raychaudhuri. Then I talk with them generally about how soil survey work is carried on in the United States. The time is too short for a complete statement. From the questions asked, I see that these people have a long way to go to understand soil survey work and to understand cooperation. I shall write home at once for examples of work plans, inspection reports, and the like.

After lunch I have a fine reception by the Standing Committee of the Board of Soil Conservation with Mr. T. C. Puri in the chair. The following members are present:

Dr. B. N. Uppal, Agricultural Commissioner, Indian Council of
Agricultural Research

Mr. G. G. Takle, Inspector General, Forests

Mr. D. Mehta (Alt. Mr. Ahuja), Central Water & Power Commission

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- (1) Organization of the Soil Conservation Service and the present philosophy and aims of our soil conservation program;
- (2) the rôle of soil conservation districts;
- (3) relations with State agencies;
- (4) relations with the Agricultural Research Service and other Federal agencies;
- (5) the watershed protection program (Public Law 566);
- (6) Great Plains program;
- (7) Soil Survey organization and functions of soil scientists;
- (8) objectives of farm planning, including relations to cost-sharing, extension programs, etc.;
- (9) kinds of soil maps;
- (10) soils and natural vegetation; and
- (11) places where Indians might be trained outside of the United States.

These topics are discussed as a result of questions. Then there are other questions about State-Federal relations. I learn that the Conservation Board makes no technical inspection of the work done under its grants. Apparently the Indian Constitution provides that most agricultural work will be done by the State

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governments. I can see that this is going to make a problem since some States have a keen interest in soil conservation and trained personnel whereas others do not.

About 5:30 p.m. I am back at the hotel and very tired after these meetings. I rearrange my baggage and special food for the trip tomorrow. Unhappily, one cannot have dinner here earlier than 7:30. Most people go to dine about 9:00. I have dinner with Mrs. M. L. Wilson, who seems very enthusiastic about India.

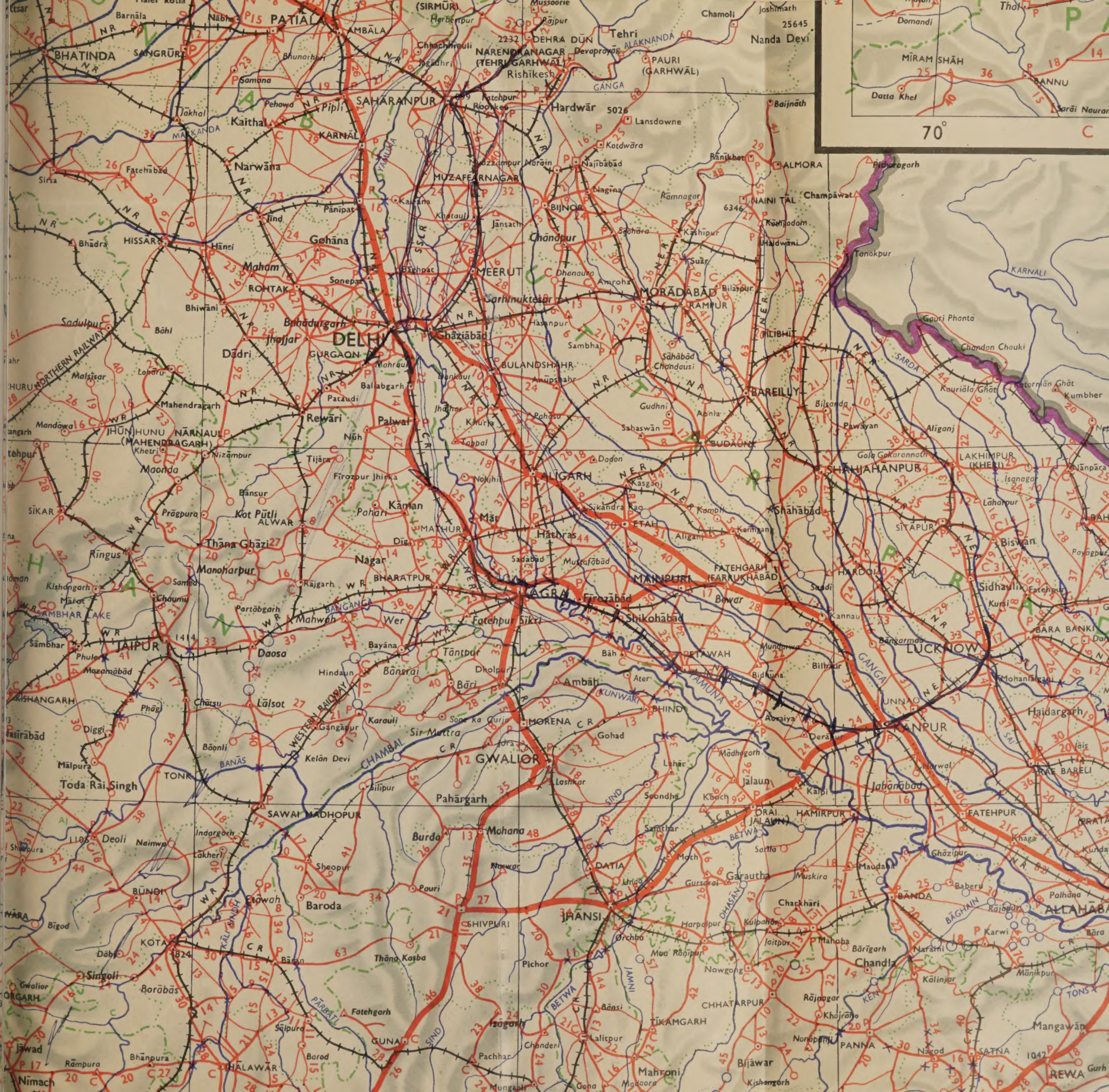
January 8: Last night I left a call, twice confirmed with the desk for 6:45. But I sleep until 7:15. After a big hurry I leave my extra baggage in Dr. Cummings' office and am ready for the trip.

I leave in a carryall at 8:45 a.m. with Mr. Nixon, Dr. Basu, and his secretary, Mr. Khullar. We cross the Jumna River on a one-way bridge.^{1/} We drive through a big alluvial plain with yellowish-brown sandy clay loam soils that are not very old. Many of these soils are rather poorly drained and show excess salt in spots. Most of the irrigation here seems to be from wells. I see mustard, wheat, pigeon peas, chickpeas, peas, and sugarcane.

I stop briefly to see flood irrigation on wheat. Most of the crop is not getting enough water. The fields are really small plots with individual farms said to be about 2 to 5 acres, although I suspect some are larger. But this total may be divided among

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Trip

(and)

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Lucknow
Trip



many small plots. For these small plots there is an intricate pattern of wells and canals with rather poor distribution of water and almost no provisions for drainage.

Along here I see more cow dung drying for fuel. We pass a flock of shorn sheep but in this section there are not many cows. I see many brick-making places doing great injury to the soil. If the upper soil is removed for 2 or 3 feet the new surface is so close to the water table that the soil becomes very salty. It could be reclaimed only with deep main canals. I note also along the high canals and the roads the same injury to the soil from using shallow borrow strips to make the grade. The result is a lot of wasteland and it seems such a pity to destroy these good soils.

A little further I stop where land is being irrigated from a well. The soil is yellowish-brown sandy loam over clay, developed from alluvium. The farmer here has about 20 acres of land including 5 acres of sugarcane. He says he uses 120 pounds of sulphate of ammonia per acre on sugarcane and some manure on other crops as well as the sugarcane. He is growing vegetables, peas, and wheat. He says he gets about 10 to 12 maunds per acre of wheat. Since a maund is about 82.3 pounds this amounts to around 16 bushels to the acre. He says he gets about 8200 pounds of sugarcane per acre that has 10 percent sugar.

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K-2394. Jan. 8, 1958. North of Delhi. A Persian type well for irrigation.



K-2395. Jan. 8, 1958. North of Delhi. A partially irrigated farm, water is running from the well in the furrow at the right to a plot of vegetables where the cultivator stands.

II

K2394

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K-2395. Jan. 8, 1958. North of Delhi. A partially irrigated
farm, water is running from the well in the furrow at the right
to a plot of vegetables where the cultivator stands.

Forty people get their living on this 20-acre farm. I notice a couple of boys with school books and they say they will be farmers. This farmer lives in the village of course, and has two buffalos and 4 bullocks for cultivation but no milk cows.

On the edge of this farm I see more wasteland from brick digging. I am told that farmers get 500 rupees for each $1/5$ acre-foot. Most of them are selling 2 or 3 feet which could mean 7,500 rupees per acre. I am terribly shocked by this waste which I had never read about in any book or report on India.

We go through the little town of Modingar which has a sugar mill and some other industries. Since this town is going from a village to a city many bricks are needed. These are hauled in by very small and rather pitiful donkeys. The cultivators bring in their loads of cane on two-wheeled bullock carts. As we go along I see much more of this good soil being ruined by the digging for brick material. I pass another fairly high canal bordered by wet salty soils from the shallow borrow pits. Such salty soils can be reclaimed only by deep drainage canals and land-forming.

As we approach the next town, I see much salty wasteland probably due to brick digging but I cannot be sure since the soil is level and has poor natural drainage. Farther along I see some mangoes, bananas, and potatoes. The soil is somewhat darker in color near Meerut - a district headquarters. This is a large town with a military camp.

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K-2396. Jan. 8, 1958. North of Delhi. Excellent soil ruined by removal of the surface 30 inches or so for bricks.

K-2476. North Delhi. Irrigated and fertilized with heavy fertilizer.

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62396

(Now our driver discovers that he is on the wrong road and we have to turn back for another road).

North of the town the soils have somewhat better drainage and part of them are not so clayey. I see a good deal of sugar



control the traffic. The trucks must stop to pay a tax. Of course

K-2476. North Delhi. Irrigated sugarcane not fully fertilized.

to the gate a truck carrying sugarcane stops and dozens of small boys swarm around and pull out stalks of the cane.

212

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North of the town the soils have somewhat better drainage and part of them are not so clayey. I see a good deal of sugarcane and some promising wheat. Yet here, too, there is a lot of wasteland from digging for brick material.

We pass Munfajnadar and then over a big canal with about the same crops as before except for somewhat more sugarcane. The mud and brick homes of the cultivators are very plain, in fact, little if any better than those in the Congo.

We pass Muzzafarnagr and continue north. At least part of the soils are fine sandy loams. I even see a few old low dunes. I notice collecting stations along the road here for the sugarcane. The cultivators bring it to these stations in their bullock carts where it is weighed and loaded on to trucks.

We pass Manolore. I see bananas, lucerne, mangoes, and the other crops mentioned before.

Along all these roads counterpoised poles serve as gates to control the traffic. The trucks must stop to pay a tax. Of course, this is another way of taxing the cultivator. Just as we come up to the gate a truck carrying sugarcane stops and dozens of men and boys swarm around and pull out stalks of the cane.

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We pass near Roorkee, a district headquarters. At the university here Professor Israelson of the United States helped to set up an irrigation experiment station. We continue on to Sharanpur. Along here there are no scattered farms; all cultivators live in villages and go out to their small fields. There is somewhat more relief again and sandier soil. I see many more trees and the chief crops are sugarcane and food crops. A few are making charcoal.

At the request of the Minister, Mr. Jain, we stop at the Fatehpur demonstration farm at 1:00 p.m. They expect us only for tea, so on this first day in the field I shall be violating my doctor's orders - to go for more than 3 or 4 hours without food.

In great haste I look at the soil here. It is nearly level and developed from alluvium. The rainfall is said to be 35 inches. This site was an old military camp and the surface soil is quite compact.

A _p	0 - 5"	Brown (7.5YR 5/2). Light sandy loam; friable but nearly massive in place.
AC ₁	5 - 19"	The soil changes gradually. It is massive, but easily friable when dug out. Particles are vesicular with medium pores.
AC ₂	19 - 32"	Transitional
C ₃₂	32+	Dark reddish-brown (5YR 3/2). Heavy sandy loam; massive but digs out in friable pieces. Pores are not numerous, but there are some Krotovinas of lighter color. This reddish-brown color seems to be mainly in the coatings around the quartz grains.

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This is a new station of about 9 acres, set aside about a year ago. They have small trials of hybrid maize with irrigation from two tube wells. They expect to have sugarcane, peas, wheat, and pigeon peas. Near here on similar soil average yields of sugarcane are about 16 tons to the acre. Wheat runs about 15 bushels per acre. Not much of either crop is irrigated. I am told that they have about 6 or 7 acres per family.

During tea with crackers, I talk with Mr. J. N. P. Singh, who is Principal of the Soil Conservation Training Institute nearby. He looks like a pretty good man. He teaches soil conservation to junior Extension people.

(Added later: During our visit Dr. Basu took samples of the soils for testing in the laboratory at the Center. Later these results were given to me and I was told I must write a letter to the Minister about this farm. The letter follows:

January 29, 1958

The Private Secretary to
Shri Ajit Prasad Jain
Minister for Food & Agriculture
Government of India
4, Hastings Road
NEW DELHI

Dear Sir:

"In company with Dr. Basu, I had a brief visit to the farm at Fatehpur about which you wished me to comment. The soil I saw is one that I should call low in present productivity now but one that is highly responsive to good management.

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"From the appearance of the leaves of young trees, I suspect either zinc or iron deficiency. With heavy fertilization such deficiencies might become even more evident. One could try sprays, separately, of about 1½ percent zinc sulphate, ferrous sulphate, and magnesium sulphate and note any possible effects on chlorotic plants.

"Under dry farming, I should expect good responses from moderate applications of nitrogen and phosphorus, and possibly from light to moderate application of potash with them. But the specific needs will have to be established through field trials, especially of potash.

"Since the soil seems to be well drained and reasonably permeable, irrigation can probably be done without special works for drainage if the water is essentially free of salt. But if the water does not drain well in some spots, these might require drainage to avoid excess salts.

"The surface soil now tends to harden because of the very low content of organic matter. This tendency can be easily corrected by working into the surface soil manure, good compost, or green manures. The growing of deeply rooted legumes, such as well-fertilized lucerne, would improve the structure of the whole soil, both surface soil and subsoil. I should suggest such a crop for one year during each 4 or 5 years of rotation with cultivated crops.

"Thus by using a system that continuously supplies some organic matter to maintain good soil structure and permeability, and by fertilization, this soil should be capable of high yields, in fact of very high yields under irrigation with high quality, salt-free water."

Very truly yours,

/s/ Charles E. Kellogg

About 2 o'clock we leave the farm and drive toward Dehra Dun. The foothills of the Himalaya Mountains come into view. From the road we see deep stream channels obviously with torrents. These get larger as we go along. At lower levels these torrents spew cobbles out onto the lower plain over good soils. The winding road takes us through a State forest and wildlife sanctuary. In certain

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"The surface soil now tends to harden because of the very low content of organic matter. This tendency can be easily corrected by working into the surface soil manure, good compost, or green manures. The growing of deeply rooted legumes such as well-fertilized lucerne, would improve the structure of the whole soil, both surface soil and subsoil. I should suggest such a crop for one year during each 4 or 5 years of rotation with cultivated crops.

"Thus by using a system that continuously supplies some organic matter to maintain good soil structure and permeability, and by fertilization, this soil should be capable of high yields in fact of very high yields under irrigation with high quality, salt-free water."

Very truly yours,

/s/ Charles E. Kellogg

About 2 o'clock we leave the farm and drive toward Dehra Dun.

The foothills of the Himalaya Mountains come into view. From the road we see deep stream channels obviously with torrents. These get larger as we go along. At lower levels these torrents spew cobbles out onto the lower plain over good soils. The winding road takes us through a State forest and wildlife sanctuary. In certain

places the hard roadbed is still wet at 2:30 in the afternoon with morning dew. We see rugged and bare hills with many pinnacles and barren slopes, especially slopes facing the south. This is a fine old British military road with many bridges, masonry retaining walls, and tunnels.

The Dun Valley comes into view and we go into it. According to Dr. Basu, most of the trees are Shorea robusta, locally called by some sol and by others sal. Even in this high valley there is considerable sugarcane along with paddy and wheat. I see some beans too and as we come to the edge of the city also potatoes, vegetables, and fruit. Here as elsewhere there are many women carrying earthen or brass pots filled with water on their heads.

We come into Dehra Dun and have a late lunch at the Quality Restaurant. Then we go to the home of Mr. Spears, an American on leave, where we are to stay for two nights.

About 4 p.m. I meet Mr. R. S. Gupta, the soil conservation officer here in charge of the research and training school. Mr. G. S. Bali, a conservation engineer, partly trained in the United States, and Mr. R. W. Kaul, a soil conservation forest officer. We discuss the program for the next two days and only now do I discover that I must change after getting settled for a speech at the Rotary Club.

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the program for the next two days and only now do I discover that

I must change after getting settled for a speech at the Rotary Club.

It is a bit cool in Dehra Dun and we go to this meeting about 8 p.m. The thing drags out at great length. Then they serve refreshments, but except for the tea, these have too much pepper for me. Finally, I give my talk, which is a rather simple one on soil conservation. I explain what it means everywhere, not simply saving, not simply erosion control. It means all technical phases focused on a complete system for a farm or a forest. The objective is high production now and in the future. I explain that good soil management consists of a combination of practices including water control and fertilization, and that the big increases in yields are the result of the interactions of all the practices. I try to point out that soil conservation is not simply the responsibility of the cultivators. The cultivator cannot plan ahead unless he has the means and incentive to do so. Thus soil conservation depends upon fair taxes, sound land tenure, credit, and stable prices. Everyone interested in the economy of India is vitally concerned. I tell them that production in India can be at least twice what it is now and perhaps more if the people want it badly enough to work for it.

We return from the Rotary Club and have dinner in the home of Mr. Spears. After dinner Dr. Basu wants me to dictate my observations to his secretary. I emphasize the great importance of doing something about these great losses of soil from large shallow excavations for material for brick making and from the wide and shallow borrow pits along the roads and high irrigation canals. I recall also that we

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K-2397. Jan. 9, 1958. Near Dehra Dun. View of fan of cobbles where mountain torrent empties onto alluvial plain.



K-2398. Jan. 9, 1958. Near Dehra Dun. Tea garden - Ambari Estate.

II

II

K2397

K-2397. Jan. 9, 1958. Near Delta Dam. View of fan of
cobbles where mountain torrent emptied onto alluvial plain.

III

K2398

K-2398. Jan. 9, 1958. Near Delta Dam. Fan section -
Arthur Roberts.

did see some chlorosis on small citrus at the demonstration farm. On the matter of torrent control, I suggest that a few of the conservationists, engineers as well as foresters, should have an opportunity to visit the excellent work done along this line in both the Italian and French Alps.

Finally to a good warm bed.

January 9: I am up at 6:20 and then breakfast. We leave at 8:20 for the soil conservation station here. It is cool, sunny, and a bit misty. The rainfall here averages about 85 inches with intensities up to 6 inches per hour. The elevation is 2,000 feet at Dehra Dun. The low temperature is about 32° F.

About 8 miles west of Dehra Dun I look more carefully at a fan of cobbles formed by torrents coming out of the foothills of the Himalayas. Locally these are called "rao." I take a quick look at the nursery where I see kudzu and other plants under test. They tell me that they sold one 60-year old sol tree for 1,000 rupees. At this rate these trees must be very valuable indeed and they are widespread in India.

I am taken to look at a soil pit in the woods. It is developed on a high, old alluvial terrace from material that looks like loess. The surface is undulating. (Mr. Gupta tries to tell me that this material is residual from metamorphic rock; clearly he is not competent for his job). I look hurriedly at the profile.

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K-2477. Near Dehra Dun. Fan of cobbles from a mountain torrent over a smooth alluvial terrace.

did not have sufficient material to fill the depression. On the right of the depression, I suggest that a low ridge of material, composed of well-sorted, rounded, and possibly of pebbles and small stones, was deposited.

2.3

2.3

2477

K-2477. Near Delta Dam. Fan of cobbles from a mountain torrent over a smooth alluvial terrace.

The terrace is well-defined. On the right side of the fan, the material is composed of small, rounded, and possibly of pebbles and small stones, was deposited.

- 32 -

A₁ 0 - 8"

Dark brown (7.5 YR 4/2). Fine sandy loam; mostly massive but thin cut in rock is regular blocky that is easily friable so upon weathering.

A₂ 8 - 18"

Dark brown (7.5 YR 4/2). Heavy clay, lower loam with weak blocky structure and shaly fracture. The soil is



about soil science is not on politics.

K-2478. Soil conservation nursery near Dehra Dun. Pennisetum p. at left; kudzu at right; and a tall sol (or sal) (Shorea robusta) tree in the background.

Wall about 30 to 35 feet high, which separates into high terrace from the lower one. The south-facing wall has a series of vertical cut in loess.

High terrace

Low terrace
with cobbles at
shallow depths

2.5

I-2478. Soil conservation nursery near Derris Dun. Pennisetum p. at
 left; Kudzu at right; and a tall soil (or soil) (Shorea robusta) tree
 in the background.

A ₁	0 - 8"	Dark brown (7.5 YR 4/2). Fine sandy loam; nearly massive but digs out in weak irregular blocky that is easily friable to poor granular.
AB	8 - 38"	Dark brown (7.5 YR 4/4). Heavy fine sandy loam with weak blocky structure easily friable. The soil has very faint large and small mottles.
B ₂	38 - 60"	Dark reddish brown (5YR 3/4) fine sandy loam to fine sandy clay loam. The soil is firm and vesicular. It breaks out into easily friable weak blocks.
C	60+	Somewhat less firm and slightly lighter in color and texture than the above.

I should call this soil an intergrade between Brown Forest and Gray-Brown Podzolic. The roots grow deeply. It is said that the surface soil has about 1.5 percent organic carbon. The pH in the surface is said to be 6.5 and about 5.0 in the B. This is very near the ideal soil for common crops.

I am told that one of the Russian soil scientists visited this same pit and according to Mr. Gupta he too thought it was a well developed soil representing probably the normal upland soil for the area. I explained that I agreed quite commonly with the Russians about soil science if not on politics.

Then we go down to the lower terrace. There is an almost vertical wall about 50 to 75 feet high, which separates this high terrace from the lower one. The south-facing wall here closely resembles a vertical cut in loess.



Dark brown (7.5 YR 4/2). Fine sandy loam; nearly massive but digs out in weak irregular blocky that is easily friable to poor granular.	0 - 8"	A ₁
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High terrace

Low terrace
with cobbles at
shallow depths

They have tried to stabilize this cliff by three different

methods:



of brown silt loam over gravel and cobbles.

K-2479. Near Dehra Dun. Face of old alluvial terrace with structure comparable to that of silt-rich loess. A little tunnel erosion along old root cavities.

I think the high terrace is an old one and that a deep valley was later cut out of it. Then that was filled with cobbles and then covered with some finer material as loess or silt like the top with 18 inches of silt loam over cobbles. Near the creek this terrace has in turn been cut out in recent times.

High terrace

Trees

216

K-2479

K-2479. Near Dohr's Dam. Face of old alluvial terrace with structure comparable to that of silt-rich loess. A little tunnel erosion along old roof cavities.

When well exposed it was no pelitic.

Low terrace
with no pelitic
structure

They have tried to stabilize this cliff by three different methods:

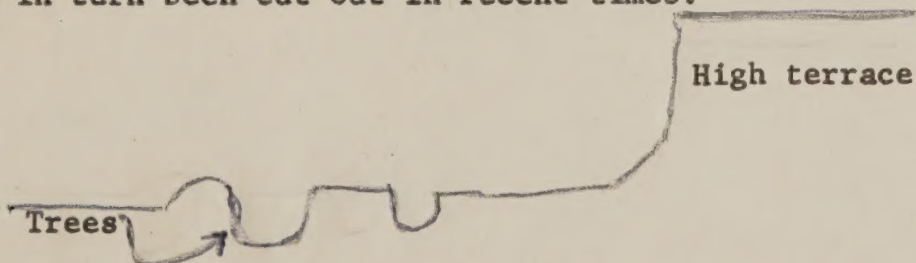
(1) They have done some slope shaping and sodding. This treatment is very expensive and I believe unnecessary.

(2) They have used diversions just back of the brink and made plantings on the lower slopes. This looks to me to be a bit expensive. With the diversions I don't think that they will have too much trouble, although some tunnel erosion can be expected through the old root channels.

(3) They have used tree plantings near the base of the cliff with diversions at the top. Water is stored for the trees on the lower terrace by a combined low ditch and bund out a few feet from the face of the vertical wall. This looks to be satisfactory to me and is not very expensive.

I look at a pit in this low terrace which shows about 18 inches of brown silt loam over grayish gravel and cobbles.

I am sure this area has gone through several erosion cycles. I think the high terrace is an old one and that a deep valley was later cut out of it. Then that was filled with cobbles and then covered with some finer material to make a soil like the one with 18 inches of silt loam over cobbles. Near the stream this terrace has in turn been cut out in recent times.



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High terrace

Trees

I am then driven to see torrent control and stream bunds of stone along with marginal spurs of stones. Wood is not satisfactory here because of termites, but of course, living trees can be used near the margins. They make the stream bunds about 6 inches below the high stream level and the spurs from the banks about 6 inches above the peak flow.

I am then shown the usual runoff plots, copied from designs in the United States, and a small experimental watershed. On this they have a big dam and measure all of the water that goes through the dam and spillway. They also measure the water from all the terraces and small branches. They now have 17 acres under control and expect soon to have 40 acres. The stored water will be used partly for irrigation and partly for fish.

I am then told I must plant a tree here at the station which I do, perhaps not with much grace since we are quite behind schedule.

After tea we drive into the hills near the outer Himalaya Mountains. Here I see many old terraces. Some of them lying over cobbles and are cut here and there with new torrents. I notice that charcoal is being made in small plants. I see wheat as a winter crop and fields for paddy, maize, and pulses in summer. Some pulses are grown as winter crops along with sugarcane. The homes here are better than they are in the plain near Delhi.

We pass a guava orchard and tea gardens under shade that are irrigated from a canal. The cropland is laid out in small paddies about 20' x 20' to 20' x 40'. Part of the higher soil apparently is not irrigated.

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K-2480. Near Dehra Dun. Cobble bunds for torrent control. The top of the bund in the channel is six inches below peak flow and the tops of the spurs are six inches above peak flow.

2.7

K-2480. Near Delta Dam. Cobble bunds for torrent control. The top of the bund in the channel is six inches below peak flow and the tops of the spurs are six inches above peak flow.



K-2481. Kellogg plants a lichi tree at the Soil Conservation Station near Dehra Dun.

K-2482. Near Dehra Dun. The Gola River, a branch of the Yamuna and of the Himalaya foothills. The mountain slopes are overcut and overgrazed. Old bench terraces have disappeared. The slopes are subject to landslides.

2.8

K-2481. Kellogg plants a lichi tree at the Soil Conservation Station near
Dehra Dun.



K-2482. Near Dehra Dun. Terraces built along the mountain slopes with winter wheat and incense.

K-2482. Near Dehra Dun. The Amla River, a branch of the Yamuna out of the Himalaya foothills. The mountain slopes are overcut and overgrazed. Old bench terraces have disappeared. The slopes are subject to landslides.

3.1

K-2482. Near Dehra Dun. The Amia River, a branch of the Yamuna out of the Himalaya foothills. The mountain slopes are overcut and overgrazed. Old bench terraces have disappeared. The slopes are subject to landslides.

After Choharper we came to the Yamuna River that passes through Balhi. From a distance I saw the level terraces on the



there is no need to duplicate these facilities at Balhi. I give

K-2483. Near Dehra Dun. Terraced soil along the Yamuna River with irrigated winter wheat and lucerne.

serial photos for a good deal of India, but that the actual coverage is classified information. I am told that if the Soil Survey or Soil Conservation Board ask about specific areas they will tell me whether or not the information is available.

3.2

K-2483. Near Dehra Dun. Terraced soil along the Yamuna River with irrigated winter wheat and lucerne.

After Choharpur we come to the Yamuna River that passes through Delhi. From a distance I can see bench terraces on the mountain slopes. There is wheat now and paddy in the summer.

Along the Amla River, a branch of the Yamuna, I see some land slides. There is thin forest on slopes of 70 to 80 percent that once had bench terraces for crops. Apparently these hills were once cultivated.

I am shown the Ashoka Edict of an early period - a big stone with writing on it, now enclosed within a small temple.

We are back in Dehra Dun for lunch at 1:00 p.m. Shortly after lunch with Mr. Nixon and Dr. Basu I go to the Survey of India. I meet Director Colonel Kalha and Brigadier Gambhir Singh, Surveyor General of India. I look at their drafting sections, color separations, and printing sections. I am very much impressed with the excellent organization and excellent work being done. Certainly there is no need to duplicate these facilities at Delhi. I also go over to the aerial survey section. I find that they have aerial photos for a good deal of India, but that the actual coverage is classified information. I am told that if the Soil Survey or Soil Conservation Board ask about specific areas they will tell them which are available.

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The Surveyor General says that they would have trouble doing the compilation work but that they would be able to do the color separation and printing. He also says that the Survey of India would help in the training of soil scientists in the use of aerial photos. Certainly the Soil Survey should take advantage of the services of this excellent organization.

We then go out to look at some of the conservation demonstrations, although it is really too late to see much. They are operating on a big gully, which has a prominent knik punt, that is cutting into a higher terrace. There is some tunneling here. They are using a masonry chute to lead the water from the diversion down to the bottom of the gulley. But not much has been done here except for the diversions and I am afraid that they are paying little or no attention to the other important aspects of soil management including improved tillage, fertilizers, pasture improvements, and weed control.

It becomes dark and we go back for dinner. I am early to bed, very tired.

January 10: We are up early to have a look at the so-called conservation project area. These are supposed to be training projects for trainees as well as demonstrations.

We drive out of Dehra Dun to the south. Here I notice some gully erosion that has been stimulated by ill-planned road ditches. We drive toward Haridwar on the banks of the Ganga (Ganges) River. Where we stop on a sloping area of old alluvium. I take a picture of a local kind of termite mound. It is said these form rather quickly. The sky is cloudy and the air misty.

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The project here is to demonstrate the use of terraces with proper terrace culture. The work is only beginning but I am not well impressed with it. Mr. B. F. Salter has a long career paper on the project in which the writer says "The project is a demonstration of the use of terraces on metamorphic rock." The statement is not correct. I have no doubt that the writer is a trained geologist.



K-2399. Jan. 9, 1958. Near Dehra Dun. Termite mound - a young one.

The project here is to demonstrate the use of terraces with proper terrace outlets. The work is only beginning but I am not well impressed with it. Mr. G. S. Balie has a long student paper on the project in which the soils are described as "residual from metamorphic rock." The statement could hardly have been more wrong. I have no doubt that this was what the student was told in the training course!

We drive back to the headquarters of the Center Soil Conservation Institute. Gupta shows me a framed "soil-type map." I explain to him that this is no kind of soil map at all and that it is very misleading. Someone has simply drawn on to an outline map sketches of soil profiles at a few spots. There is no soil classification, nomenclature, or boundaries. Obviously, gupta has no concept whatever of what is a soil or a soil map, or how a soil map is made.

Then I give a lecture on soil survey, for about an hour, to the trainees on soil conservation and soil survey. I can see from the questions that the training here has been quite poor indeed.

Then I discover that a short press conference has been scheduled! (Added later: The reporters did well for the short time. I explained that production could be increased by 2 or 3 fold if they were willing to work hard for it. (These last few words were, unfortunately, omitted). I also emphasized the great and unneeded loss of excellent soil by shallow digging for material for bricks. The story went all over India and showed up on the agenda of Mr. Nehru's conference with his ministers).

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with his ministers).

We return to the Spears' home for lunch and leave just a little after 12 noon for Delhi. We go west to Saharanpur. On the way we drive through the forest research institute which was started in 1901. As we move on southwest the plain has considerable relief because of river terraces of different age. The more clayey soils seem to be used for paddy. The wheat crop shows nitrogen deficiency in many places. We pass through a forest reserve and the Rajaj Sanctuary for wildlife. The land is very hilly and we drive on a winding road through low jagged mountains called the Siwalik Mountains.

I am told that here the standard recommendation is for the cultivators to plow 9 times before planting. I am sure that this is far too much and injures the structure of the soil.

We leave the mountains and come out on a gently sloping plain. The soils from the alluvium appear to be underlain by cobbles at 2 to 4 feet and deeper. I stop to look at the cultivators now plowing paddy soil for onions. There are scattered wells for irrigation in the form of little shallow circular pits. The soil here is an ill-drained grayish brown light sandy clay loam with a water table now at 30 inches. This area badly needs a little drainage and water control for good paddy yields.

We then pass into a slightly undulating sandy plain. I am a bit surprised to see sugarcane on these sandy soils. Most fields show nitrogen deficiency and some phosphorus deficiency. We then

We return to the Spears' home for lunch and leave just a little after 12 noon for Delhi. We go west to Saharanpur. On the way we drive through the forest research institute which was started in 1901. As we move on southwest the plain has considerable relief because of river terraces of different age. The more clayey soils seem to be used for paddy. The wheat crop shows nitrogen deficiency in many places. We pass through a forest reserve and the Rajaji Sanctuary for wildlife. The land is very hilly and we drive on a winding road through low jagged mountains called the Siwalik Mountains. I am told that here the standard recommendation is for the cultivators to plow 9 times before planting. I am sure that this is far too much and injures the structure of the soil. We leave the mountains and come out on a gently sloping plain. The soils from the alluvium appear to be underlain by cobbles at 2 to 4 feet and deeper. I stop to look at the cultivators now plowing paddy soil for onions. There are scattered wells for irrigation in the form of little shallow circular pits. The soil here is an ill-drained grayish brown light sandy clay loam with a water table now at 30 inches. This area badly needs a little drainage and water control for good paddy yields. We then pass into a slightly undulating sandy plain. I am a bit surprised to see sugarcane on these sandy soils. Most fields show nitrogen deficiency and some phosphorus deficiency. We then



K-2400. Jan. 10, 1958. North of Saharanpur.
Plowing old paddy for onions.



K-2401. Jan. 10, 1958. North of Saharanpur.
Local people near shallow well used for irrigation.

III

K2400

K-2400. Jan. 10, 1958. North of Saharapur.
Plowing old paddy for onions.

II

K2401

K-2401. Jan. 10, 1958. North of Saharapur.
Local people near shallow well used for irrigation.

go into an area of fine sandy loam formed from alluvium like the soils seen on Wednesday (Jan. 8). How the Dutch soil scientists and engineers would make this soil really produce! They have the water and soil here for extraordinarily high yields.

As we cross the Hindan River I see people planting melons in a river bed just above the present low water.

We pass Saharanpur, a district headquarters. As we leave the town I see a lot more wasteland as a result of removing material for bricks, and other ill-drained soil besides.

(I am told that the workers on the roads here get about 1-1/4 rupees per day. Of course, they are not very good workers and with that income they lack proper nutrition and medical attention).

Along here I see some scattered farms as well as villages. It is too bad that people speak of these soils as "alluvial" soils with the connotation that they are relatively uniform. Actually, a proper soil survey would show many different soil series because of great differences in texture, structure, color, and consistence of the several horizons because of differences in the original alluvium due to fluctuating speeds of the water that deposited the material, in age, in climate, in depths of the water table at various seasons, and in the composition of the water.

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Again the agricultural land is interrupted by large areas of wasteland resulting from digging out soil material, thus leaving the soil too shallow over the water table and salty. With modern earth-moving machinery for water control and a little land forming and with fertilizers enormous areas of unused soil here could be made highly productive.

We pass Samli. Again there is a mixture of wet land and soils like those seen before. Besides the destruction due to brick making, there are large strips of waste along the roads and large irrigation canals from shallow borrow pits.

There are lots and lots of people on the road. They are almost packed into the village streets. Many are working in the fields and many others are just sitting in the fields. Lots of women are carrying cut fodder on their heads for their animals.

About 12 miles out of Delhi I see a great deal of salty wasteland. Along here we pass two very old hill towns. These hills were obviously made from scraping up the soil from a large area. It was probably carried in baskets on the head to make these hills. Thus this area of wet and salty wasteland has been in existence for a long time.

I am back in my hotel in New Delhi about 5:00 p.m. We plan to leave in the morning at 8:00 with Mr. Nixon and Mr. Rama Rao. I get cleaned up and rearrange my baggage for the trip in the morning. I am told that Dr. A. H. Moseman will come in from New York City about midnight, but I shall leave too early to see him.

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This evening I am very tired. It is a great pity that much better use is not made of these highly responsive soils in the great alluvial plain. Our soil scientists, conservation engineers, and soil conservationists in the United States could increase production several fold with the proper use of machines and fertilizers. It makes one wonder how hard these people really work. With the present system it seems to me that during much of the time the cultivators have little or nothing to do. With both conservation planning, including farm budgeting, the labor requirements could be far better distributed.

January 11: I am up to have myself ready for an 8 o'clock departure. While at breakfast a driver calls for me at 7:30. There must be some kind of mistake and I dare not go with him. I ask him if he is for Dr. Kellogg, and he answers "yes." Then I ask if he is for Dr. Moseman, and he answers "yes." In fact, he answers all my questions with "yes."

Finally Dr. Parker comes and agrees to drive out and find Dr. Cummings. Eventually Dr. Cummings and Mr. Rama Rao, Director of Soil Conservation (Engineering) get here, the driver gets instructions, and we go to pick up Mr. Nixon. But we apparently look over every house in one large district before they find where he lives. After all this trouble we finally get away at 9:25.

It is warm, sunny, and misty. We take the main road from Delhi to Agra - the city of the famous Taj Mahal. There are many ruins and remains of digging along the road, partly from digging for road-grade

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material and partly from digging for brick material. Here they are widening the road. Nearly all the work is done by hand. The laborers are not strong. Their legs are thin and nearly emaciated. They work slowly and rest a great deal in a squatting position.

I see lots of mustard and wheat mixed with mustard. This wheat appears to promise about 15 bushels per acre. Also, there are pigeon peas and stacks of munj (Saccharum mungea), a tall grass used for windbreaks to control soil blowing.

Mr. Rama Rao tells me that many of the young civil engineers do not want to change to soil conservation work because the organization is still temporary. I shall certainly do what I can to get this situation changed. Otherwise they will not be able to get good people willing to work in the field.

Near the village of Banchar I see some fields of peas and a great deal of sandy waste area that probably resulted from the making of a nearby hill town many years ago. I take some pictures in the village including one of a peasant with water pipe. These old villages have very poor houses and no arrangements whatever for sanitation. One villager seems to object a bit and asked me, "Why take pictures of bad things?" I explain that I try to take pictures of both good and bad.

We drive on and pass Kosikalan. Here too, there is much wasteland from digging and from overgrazing with sheep and goats. We see quite a few old ruins. We pass another old village on a hill with the accompanying wasteland resulting from old diggings. Beyond this there is another old hill village with wasteland; then another, along with several old temples.

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K-2402. Jan. 11, 1958. Banchar, southeast of Delhi.
Road through village.



K-2403. Jan. 11, 1958. Banchar, southeast of Delhi.
Women bearing fuel.

K2402

K-2402, Jan. 11, 1958, Banner, Southeast of Delhi.
Road through village.

III

K2403

K-2403, Jan. 11, 1958, Banner, Southeast of Delhi.

Women bearing fuel.



K-2404. Jan. 11, 1958. Banchar, southeast of Delhi.
Courtyard in the village.



K-2405. Jan. 11, 1958. Near Agra. Smoothed soil of
lowland looking into irregular, gullied scarp.

III.

III

2424

K-2404. Jan. 11, 1958. Beach, southeast of Delhi.
Country in the village.

1

III

2424

K-2405. Jan. 11, 1958. Near Agra. Smoothed soil of
lowland looking into irregular, tilted scarp.

We pass Chhata. The soil here looks very dry now and apparently there is only a little irrigation. The cultivators have pigeon peas, wheat, and wheat mixed with mustard. Some spots are salty and the crops are poor. Some of the low clayey areas have probably resulted from ancient diggings.

A little beyond I see many fields of munj and other crops that are a bit better. The number of trees increases as we pass Choma. There is at least some irrigation between that village and the next one - Mathura. Here there has been considerable tree planting in narrow strips along the road by the Forest Service. We are now about 20 miles from Agra and there is not much irrigation.

We pass near the tomb of Akdar, the father of the builder of the Taj Mahal. Ruins of old temples dot the landscape all about. There are many excavations for brick material. We come to Agra about 1:00 p.m., and register at the hotel and have lunch. This is said to be a city of about 700,000 people and also at one time the resident city of the Mongol Emperor. The annual rainfall is about 29 inches.

After lunch we go to the soil conservation research station nearby along with Mr. A. B. Phadke, the officer in charge.

As usual, the streets are very crowded with buffalos, cows, bullock carts, bicycles, rickshaws, and tongas, little carriages pulled by horses.

As we near the city I see some castor beans in addition to wheat, mustard, and munj. There is irrigation here only from wells.

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A SHORT NOTE ON THE PROGRESS MADE AT THE SOIL
CONSERVATION RESEARCH DEMONSTRATION & TRAINING
CENTRE, AGRA SINCE ITS INCEPTION.

* * * * *

1. ORGANISATION:-

Immediately after the centre started functioning on 28.11.55, a suitable accommodation for the Centre's office was secured. This was followed by inspection of suitable sites for the location of the Research Demonstration & Training Farm of this centre. The present site at Chhalesar to the south of the Chhalesar Railway Station, comprising of an area of 201.56 acres, mostly of ravines was finally selected after inspecting 6 different sites. The possession of the farm site was made over to this centre on 24.8.56 after the necessary land Acquisition proceedings were completed. The land has been acquired by the Government of Uttar Pradesh and transferred to this centre free of cost. The intervening period between the inception of the centre and the starting of the actual work was utilised in formulating estimates for necessary equipments required, and for recruitment of the nucleus staff required to start a new station.

In addition to the above, technical studies of the ravines of the farm site were also undertaken to know the nature of the ravines, causes of their formation, and find out what trees and grasses are locally growing and collection of data regarding the regional Geology, types of soil of the track climatic conditions, rainfall records of past 25 years, principle crops and their yields and irrigation facilities and mode of farming etc.

2. DETAILS OF WORKS:-

(1) Immediately after the possession of land was taken over, permanent demarcation of the farm area was made by fixing boundary stones. Similarly plane-table survey of the area has been completed and a detailed map on a scale of 55' to 1" has been prepared showing the locations of all ravines, their bank slopes and depths and width of the ravines beds. This was necessary for future planning. A technical programme outlining the following experiments to be carried out at the farm was prepared and submitted.

- (1) To investigate and collect information on trees, shrubs and grasses suitable for soil conservation works.
- (2) To study splash erosion on bare ground, under grass cover, under natural vegetation and under suitable forest canopy.
- (3) To study the effect of plantings in pits, moulds and ridges.
- (4) To study the effects of various organic and inorganic manures on the growth and establishment of forest and grass species to be introduced in the area.
- (5) To study gully plugging with different kinds of check dams and also to evolve suitable spacing of check dams on various slopes.
- (6) To study the effects of various depths of humus layers on the retentivity of rain water and the rate of runoff.
- (7) To study different types of hedges suitable for soil conservation farms.

Contd. on next page.

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- (1) To investigate and collect information on trees, shrubs and grasses suitable for soil conservation works.
- (2) To study splash erosion on bare ground, under grass cover, under natural vegetation and under suitable forest canopy.
- (3) To study the effect of plantings on soil, wind and tides.

- (8) To study the rate of runoff and soil losses on different slopes.
- (9) To study the chemical composition of the soil and the PH value before the introduction of forest and fodder crops and after the introduction of these crops and its variation from time to time.

(II) (1) The entire farm area of nearly 15,000 R.Ft., the staff colony area, Nursery area, Runoff plot and the Meteorological area were fenced.

(2) A tree and grass Nursery has been established in an area of 2 acres.

(3) A set of 8, Runoff plots with multislot divisors is being set up on a 2% natural slope to find out the rate of runoff and soil losses.

(4) An Agricultural Meteorological field unit is being set up on the Farm and the following instruments have been set up.

- (i) Ordinary Rain gauge.
- (ii) Anemometer.
- (iii) Wind Vane.
- (iv) Soil Thermometers.
- (v) Grass Thermometers.
- (vi) Maximum and Minimum, Dry & Wet bulb thermometers
- (vii) Sunshine Recorder and U.S.A. Pattern evaporimeter have been received and would be soon set up.

Arrangements have been made to procure the following instruments.

- (i) Automatic Rain gauge.
- (ii) Hair Hygrometer and Thermograph.

A Record Room has been constructed for the use of the observer to maintain records and equipments in connection with the Field unit of Agricultural Meteorology.

(5) As a preliminary to take up the Cropping Schemes both in Kharif and Rabi, an area of about 60 acres of marginal lands at the head of ravines was tractor ploughed and banded. During the Rabi season of 1956-57 an area of about 10 acres was brought under Rabi cropping Scheme, the crops mainly being restricted to legumes to increase the fertility of the soil. Similarly cropping Schemes for Kharif and Rabi seasons of 1957-58 for an area of 25 and 15 acres respectively have been undertaken with different spacings and different seed rates. Green manuring crops were raised in an area of 5 acres during Kharif of 1957.

(6) Two wells are being sunk, one in the Nursery area and one in the staff colony area.

(7) Hatted accommodation has been provided for the field staff of this centre in the colony area which has been acquired for the construction of the permanent buildings. The colony area has been planted up with different kinds of trees. In addition temporary sheds have been constructed for the bullocks, for accommodating the Agricultural implements and for the temporary shelters for the labourers and watchman.

(8) The purchase of a small tractor with the necessary equipments has been sanctioned. In addition water cart

Cont.

with a tank of 200 gallons capacity and a bullock cart have been purchased.

(9) An approach Road to the Farm for a length of 4000 R.Ft. and internal inspection paths for a length of 4852 R.Ft. have been constructed.

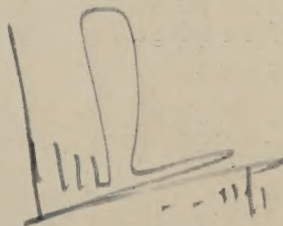
(10) A land use plan for the entire farm area has been prepared on the lines suggested by Dr. R.M. Gorie, F.A.O. Expert. An estimate for reclamation of about 60 acres of Ravine land with the help of bulldozer has been prepared and sent to the Ministry for sanction as a part of the Technical programme. Similarly a small ravine area is being levelled and terraced with manual labour and bullock power to find out the comparative cost of such levelling and terracing to be later on compared with the cost of levelling and terracing by machinery.

(11) Systematic forest plantation has been completed in an area of about 10 acres. Different kinds of tree-s have been planted along the northern boundary of the farm for a length of 5000 ft. and a width of 30 ft. to demonstrate the types of species to serve as wind breaks. Similar planting has been done along the boundary of block No. 1 and is contemplated to be completed along the boundaries and the remaining blocks to serve as wind breaks. Attempts have been made to raise babool and shisam on the left bank of Jamuna with a view to stabilise the bank and raise the bank level if possible. Along the eastern and western boundaries of the farm comprising a total length of 8400 R.Ft., Agava Americana have been raised to serve as a live hedge.

(12) As the soil and water of the terrain is considered suitable for cultivation of tobacco, Experimental tobacco plantation has been raised in area of .25 acres.

(13) Eight soil samples from different sites in Block No. 1 where most of the cultivable lands are situated, have been collected and the mechanical and chemical analysis is being done at the Agricultural farm laboratory of the B.R. College, Bichpuri, Agra. The results are yet awaited.

(14) Two diversion Chhanals have been constructed to drain off the surplus water from the cultivated area, which otherwise used to damage the bunds during the rains.



(A. B. Phadke)
Asstt. Soil Conservation Officer,
Agra.

Near the river there is quite a bit of relief. The side streams from the rivers have cut down into the soft alluvium and these side streams have many gullies entering into them. I am told that this condition is quite common in the plain with about 3 to 3½ million acres of such gullied soil in Uttar Pradesh alone.

We drive out on the top of a sort of ridge between these gullies. The soil is a truncated Brown soil over loamy fine sand. The upper 2 feet in the prepared pit is the lower part of an old truncated soil profile.

B _{3p}	0 - 10"	Yellowish-brown fine sandy loam, firm but friable when removed. There are some small lime concretions.
C _{ca}	10 - 30"	Light yellowish-brown, light fine sandy loam with large sandy calcium carbonate concretions about 1½ to 2 inches long. The material is nearly massive in place, but digs out easily.
D	30+	Light yellowish-brown (2.5Y 6/3) light loamy fine sand; very soft and highly erosive.

The gullies probably get started in this relatively dry region during periods of extreme drought and overgrazing. The surface exposed directly to the sun becomes massive and hard. Yet with guarding against grazing it is truly amazing how much good grass comes up.

Like other stations, there is a full set of runoff plots here that are really not needed. I see some good terracing and some good diversions with masonry chutes leading the water to the bottom of the gullies. They have done quite a good job.

From gully bottoms I note several layers of alluvium, some of them quite clayey. Some of the layers contain small ferro-manganese concretions.

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K-2406. Jan. 11, 1958. Near Agra. Good grass on gullied land after one year of protection from grazing.



K-2407. Jan. 11, 1958. Near Agra. Experimental plantings near Yamuna River.

IV

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K-2406. Jan. 11, 1958. Near Agre. Good grass on cultivated land after one year of protection from grazing.

IV

K-2407

K-2407. Jan. 11, 1958. Near Agre. Experimental plantings near Yuma River.

These gullies can be controlled by guarding against grazing with some plantings near the base of the slopes. Then the gully bottom may be smoothed for crop production.

While I am looking at the tall grass and bushes here I see some wildcats, but I don't catch any.

We have tea in the station and then drive back toward our hotel in Agra. We stop for a moment to see a famous structure called Itmaduddaulas' tomb. The 3 outside buildings are red sandstone with marble inlay. The center building is of white marble with beautiful colored inlays. A nice garden is maintained but the place is almost overrun with wild monkeys. The monkeys in India are very tame since no one catches them for soup as would be the case in Africa.

We have a long delay getting back over the river. The local people tell me that these bullock carts cost about \$100 a piece and that good bullocks are worth \$200 a pair.

I am back to the hotel at 5:45 for a brief rest before dinner. This station in Agra is better planned and managed than the one at Dehra Dun. I am well impressed with the clear picture that Mr. Rama Rao has of the whole soil conservation job to be done.

After a little chitchat with Nixon I am early to bed.

January 12: Last night the people in the next room awakened me with their loud singing. I slammed on the door very hard two or three times and I think it startled out all the desire to sing. But then the dogs started to bark. With the daylight at 6 o'clock the dogs howl again, donkeys bray, car motors are started, and so on.

These gullies can be controlled by guarding against grazing with some plantings near the base of the slopes. Then the gully bottom may be smoothed for crop production.

While I am looking at the tall grass and bushes here I see some wildcats, but I don't catch any.

We have tea in the station and then drive back toward our hotel in Agra. We stop for a moment to see a famous structure called 'Itmad-ud-Daula' tomb. The 3 outside buildings are red sandstone with marble inlay. The center building is of white marble with beautiful colored inlays. A nice garden is maintained but the place is almost overrun with wild monkeys. The monkeys in India are very tame since no one catches them for soup as would be the case in Africa.

We have a long delay getting back over the river. The local people tell me that these bullock carts cost about \$100 a piece and that good bullocks are worth \$200 a pair. I am back to the hotel at 5:45 for a brief rest before dinner.

This station in Agra is better planned and managed than the one at Dehra Dun. I am well impressed with the clear picture that Mr. Rama Rao has of the whole soil conservation job to be done. After a little chitchat with Nixon I am early to bed.

January 12: Last night the people in the next room awakened me with their loud singing. I slammed on the door very hard two or three times and I think it startled out all the desire to sing. But then the dogs started to bark. With the daylight at 6 o'clock the dogs howl again, donkeys bray, car motors are started, and so on.



K-2409. Jan. 12, 1958. Agra. Looking down the Yamuna River from the Red Fort toward the Taj Mahal (very misty). Temporary culture in river bed.



K-2408. Jan. 12, 1958. Agra. Yamuna River from Taj Mahal. Melon culture in river bed.

10409
K-2402, Jan. 15, 1958. Ayr. Looking down the Yomama
River from the Red Fort toward the Taj Mahal (very misty).
Temporary culture in river bed.

12408
K-2403, Jan. 13, 1958. Ayr. Yomama River from Taj Mahal.
Tajon culture in river bed.

This is supposed to be partly a rest day. At 9:30 I go to visit the famous Taj Mahal. The designs are mostly of flowers and plants in bas relief and inlay in white marble. There is no doubt it is a beautiful building. I am told that it took 22,000 people 17 years to construct it. It contains the tomb of Emperor Shah Jahn (1627 - 1687) and his favorite wife who had 14 children. Cost estimates range from 5 to 60 million rupees.

Then we drive through the crowded streets - crowded with bullock carts, cows, people, and camels even on Sunday - to the Red Fort, said to be about 300 to 400 years old. I try some pictures looking down the river from the Red Fort to the Taj Mahal but it is very hazy.

We go back to the hotel for lunch and then to the railway station at 1:40 p.m. Here I meet Dr. Raychaudhuri and his secretary, S. K. Sood, along with Mr. Satyanarayana, the soil correlator for the alluvial plain. Mr. Nixon and Mr. Rama Rao are driving back to Delhi this afternoon. With the others I leave for Kanpur at 3:25 p.m. We have a very clean air-conditioned room but unhappily the coach is turned around so we ride backward.

I notice here that many of the wells have an inclined plane away from the well and there are pulleys at the top of this plane directly above the well for ropes. Buckets attached to these ropes are pulled out by bullocks walking down the plane away from the well. This is called the charsa system for taking water from deep wells (See photo K2460). I am told that the Persian system, near Delhi, where the

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cattle go round and round in a ring, doesn't work well if the water is much over 16 feet.

As we go along the train I see fields with mustard and wheat planted in rows between pigeon peas and also fields with alternate rows of mustard and chickpeas. I am told that pigeon peas in this dry area yield about 300 pounds to the acre. I note some terracing on gentle slopes and a little irrigation from wells.

As we pass Tundla the area is a bit more humid. There are more trees, better crops, and less gullying. This confirms my earlier judgment that the gullies get started during periods of great drought.

The train moves along quite slowly. Beyond Firozabad I see saline soils something like those north of Delhi although I believe these are due to natural poor drainage, although some spots have been aggravated by digging out material for making bricks and road grades.

It is soon dark and I have long discussions with Raychaudhuri about soil surveys and other soil research. He outlines some factors reducing yields in these drier areas: (1) Most of the animal manure is used for fuel; (2) the animal bones are picked up from the land and exported; (3) there is too little green manure because of the heavy population and pressure for food crops, and (4) increasing sheet erosion.

We arrive at Kanpur station at 8:35 p.m. Mr. C. L. Mehrotra takes me to my hotel - Barkeley House. I go in a perfectly terrible jeep in which I am supposed to ride 90 miles tomorrow in order to see the soils! This hotel seems to be quite old and a bit mangy.

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It seems that the chief chemist, Dr. Agarwal, is ill. The others have been told to show me the soils. I asked especially to have the detailed maps with us in the field, but Mehrotra says there are no detailed maps for nearby areas. But he is not very convincing. (I believe this is the same fellow that pushed me very hard to give him a color book and a 1938 Yearbook in my office a few years ago.)

January 13: I have a good sleep interrupted by factory whistles. Although I am carrying a bedroll like nearly everyone else I did not need to use it last night. By the morning paper I read that in several districts both elephants and tigers are doing much damage to people and crops.

This town is said to be the "Manchester" of India with its many textile mills. I am up at 7:00 the air is cool and hazy. In the hotel gardens I notice that they use 3-inch galvanized sheet iron pipe for irrigation. The individual pipes are 3 to 15 feet long and slightly tapered at one end. In the garden are roses, chrysanthemums, nasturtiums, coxcomb, candytuft, ageratum, daisies, sweet william, salvia, palms, aucuba, and many others.

I am ready to leave at 8: a.m., but my Indian escorts are late. It is too bad that Dr. Agarwal is ill and cannot go out in the field today. I was told last night that the only transport for the Soil Survey here, which is financed by the State, is one jeep and bicycles.

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We finally leave the hotel about 9:00 with Raychaudhuri, Mehrotra, and others. Both the bullocks and the bullock carts here are smaller than those near Agra.

We go out to see the recent fine sandy alluvial soil along the banks of the Ganga River. The land is usually flooded annually. In years when they expect no flood sugarcane is planted in February and harvested in December. They also grow vegetables and melons.

I look at the soil in a pit. It is a grayish-brown (2.5Y 4½/2) silt to silty clay loam, massive but friable. There are very fine sandy loam layers and grayish-brown sand beneath. This seems to be a reasonably stable alluvial bottom only occasionally flooded. The soil is now moist and there are a few vertical cracks beginning in the surface. In the lower channels the soil is loamy fine sand.

In plowed fields the surface soil is quite hard in the surface.

I notice some men working very hard preparing this soil for melons. They dig great pits from 4 to 5 feet deep, partially fill these with loamy sand, and plant the melons so the roots can reach the ground water. As the melons grow the pits are gradually filled. They also use mung windbreaks to protect the plants. Some of them use both manure and ammonium sulphate as fertilizer. I note that these workers get 1 and 1/4 rupees per day.

When they dig out the clayey silt to about 4 or 5 feet they replace the lower part with sand so that just before planting the final pits are only about 10 inches below the ground level. In this way any recently deposited silt is removed. The lower material is said to be somewhat calcareous.

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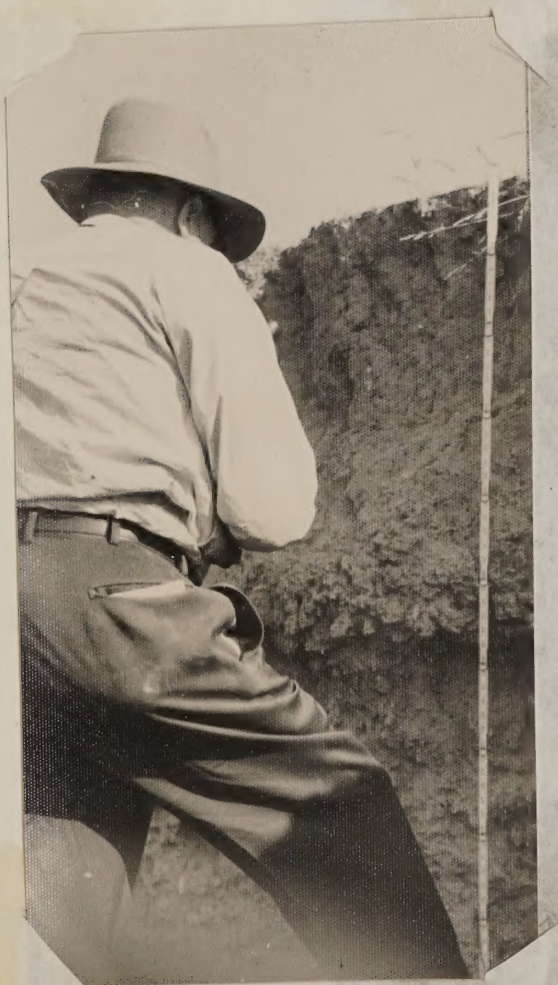
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In Allen Forest Area, near Kanpur, Soil type No. 1 below,
fresh alluvium above. (S. P. Raychaudhuri.)



K-2410. Jan. 13, 1958. Kanpur. Digging out upper 2 feet of silt of river bed for melon culture.



K-2411. Jan. 13, 1958. Kanpur. Undressed profile of Kanpur type No. 1. Note croute calcaire - a bit more prominent than normal with lateral movement and drying.

III

K2410

K-2410. Jan. 13, 1958. Kanpur. Dissecting out upper 2 feet
of silt of river bed for pollen culture.

K2411

K-2411. Jan. 13, 1958. Kanpur. Unpressed
profile of Kanpur type No. 1. Note crumpled
calcareous - a bit more prominent than normal
with lateral movement and drying.

We then drive up to a somewhat higher terrace where the soil is called Kanpur type No. 1, or the first stage above the alluvium. At the first one the pit is so deep that I cannot get in it and it is not well placed so the profile description is quite rough:

Ap	0 - 6"	Very pale brown (10YR 7/4) light silt loam. Massive in place but fairly easily friable.
	6 - 18"	Transitional
	18 - 40"	Brownish-yellow (10YR 6/6) fine sandy loam. Nearly massive but digs out as a friable mass.
	40+	Similar to above but with both large and small calcium carbonate concretions.

(Mehrotra says that the calcium carbonate and clay moved down but I see little evidence of clay movement). This lower material is a very fine sandy loam, massive in place that digs out in weak, subangular, medium blocky. The peds are easily friable. There is no evidence of waterlogging.

I believe that the soil here has been considerably disturbed. Across the road on a slightly higher terrace the concretions come at 24 inches and I photograph an undressed profile.

Here too the trees are guarded by iron mesh work about 4 feet high. A lot of iron is used this way in India. In the edge of the city there is much new housing and much wasteland from old diggings. We drive south by an old temple. We cross a large irrigation canal, still in the big suburban development. At about 3 or 4 miles we turn west on the main road to Bombay past Panki and turn toward the Pandu River. Here there is rather bleak wasteland with few trees. There has been much old digging and some salt has accumulated. At about two miles we pass a large canal from the Ganga River that is used partly for navigation but mainly for irrigation. I see some peas, mustard, and

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vegetables. The soils near the roads and canals in the old diggings are wet and saline. They are said to be mainly of the Kanpur type No. 2 with an illuvial B. I am told that these soils have only about 25 to 30 percent clay. I doubt the accuracy of these analyses. I don't think all the clay has been dispersed. (Added later: In every laboratory I saw in India, the jars of dispersed soil were exposed to drafts and to uneven sunlight with no protection.)

My guide tells me that one cannot go deeper for bricks because the lower layers of material are sandy. I doubt this because I have seen some deep ones, although most are shallow. But I believe they are shallow mainly for ease of working. This very serious problem is in urgent need of attention. The losses of good soil from these diggings probably much exceed the erosion losses in this plain. Then irrigation without drainage causes other great losses of soil.

I look at a profile of the Kanpur type No. 2.

A _p	0 - 7"	Pale brown (10YR 6/3) fine sandy loam; hard when dry; permeable, but friable.
AB	7 - 13"	Transitional.
B ₂	13 - 46"	Brown (10YR 5/3) light sandy clay loam. In place there are some vertical cracks. The soil breaks into medium subangular blocky. The vesicular peds are fairly friable. The soil contains many roots.
B _{3ca}	46 - 67"	Transitional, with some small and large concretions of calcium carbonate.
C	67+	Light olive brown (2.5Y 5/4) very fine sandy loam; massive in place, but easily friable.

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B _{3ca}	46 - 67"	Transitional, with some small and large concretions of calcium carbonate.
C	67+	Light olive brown (2.5Y 5/4) very fine sandy loam; massive in place, but easily friable.

The C is moist but the other horizons are now dry. The surface is nearly flat and the profile has been made at the edge of a brick works. The roots in the upper soil are of Bermuda grass.

In this place they are using the C as well as the A and B for making bricks.

I try for some photographs. A woman is crouching down to make the material into mud. The lime concretions are sorted out to use for making lime. All of the low places here have salts. I have never seen a greater waste of good soil.

We go on west over the Pandu River. We pass an asylum for useless cows. This one has about 1,000 of these old animals maintained by an endowed society.

We drive out into a large flat of slightly ill-drained heavy saline soil. The area is very heavily grazed and is dotted with a few thorny bushes. The soil is called the halomorphic phase of Kanpur type No. 2. But it is not simply halomorphic. Perhaps it was first formed under the influences of a water table rich in calcium, then truncated, and later salinized. Some concretions of lime are at the surface. It is said that water stands on the soil during wet periods. My local guides think that the area was never spoiled by digging but I think it may have been. The white spots were said to contain sodium carbonate and I am told that the exchangeable sodium is very high.

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K-2412. Jan. 13, 1958. Near Kanpur. Soil being ruined by brick makers.



K-2413. Jan. 13, 1958. Near Kanpur. Landscape on halomorphic phase of Kanpur type No. 2, (truncated Brown soil from alluvium, with croute calcaire, later salinized).

Strong brown (7.5YR 5/6 to 5/6) fine sandy clay loam; nearly massive in place; digs out as rather irregular blocky that is fairly easily friable.



K2412

I have found K-2412, Jan. 13, 1958. Near Karpur. Soil being
relieved by brick makers.

K2413

collected by K-2413, Jan. 13, 1958. Near Karpur. Indurated on
halomorphite phase of Karpur type No. 2, (truncated
brown soil from alluvium, with coarse calcareous, later
salinized).

The surface soil of about 12 inches is pale brown, hard, very fine sandy loam. This is underlain by croute calcaire, about 12 to 20 inches thick and made up mainly by the cementation of large numbers of calcium carbonate concretions, locally called "kankar." Below the croute calcaire is mostly mottled yellowish-brown and gray very fine sandy loam. It is now moist and compact, but becomes very hard when dry. It is said that the water table shifts about 16 feet up to the surface. There is a bit of micro-relief and some puffed spots. The soil looks to me like a truncated Brown soil from alluvium, with hard nodular croute calcaire, that has become salinized. I have a little difficulty understanding how it has such a high content of sodium carbonate. There are no morphological features suggesting Solonetz.

We go west beyond the 11 mile post from Kanpur. The area of salty soil here is about 1 mile long and 3/8 mile wide.

Then we pass into Kanpur type No. 3 - the so-called mature soil which is said to be most responsive to management. There are more fruit trees, especially mangoes, along with mustard and the other crops common to this area - wheat, pigeon peas, chick peas, etc.

We look at a profile:

A _p	0 - 6" $\pm$ 2"	Pale brown (10YR 6/3) light fine sandy loam; now brittle but easily crushed to dry dust.
B ₂	6 - 33"	Strong brown (7.5YR 5/6 to 4/6) fine sandy clay loam; nearly massive in place; digs out as medium subangular blocky that is fairly easily friable

The surface soil of about 12 inches is pale brown, hard, very fine sandy loam. This is underlain by croton caliche, about 12 to 20 inches thick and made up mainly by the cementation of large numbers of calcium carbonate concretions, locally called "kankar." Below the croton caliche is mostly mottled yellowish-brown and gray very fine sandy loam. It is now moist and compact, but becomes very hard when dry. It is said that the water table shifts about 16 feet up to the surface. There is a bit of micro-relief and some puffed spots. The soil looks to me like a truncated Brown soil from alluvium, with hard nodular croton caliche, that has become salinized. I have a little difficulty understanding how it has such a high content of sodium carbonate. There are no morphological features suggesting Solonchaks.

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We look at a profile:

Ap	0 - 6" ± 2"	Pale brown (10YR 6/3) light fine sandy loam; now brittle but easily crushed to dry dust.
B ₂	6 - 33"	Strong brown (7.5YR 5/6 to 4/6) fine sandy clay loam; nearly massive in place; digs out as medium subangular blocky that is fairly easily friable

B ₃	33 - 51"	Transitional
C	51+	Light yellowish-brown (2.5Y to 5Y 6/4 to 6/6) loamy fine and very fine sand. Compact but very easily friable.

Roots go down into the C. The soil is said to be neutral. The local people account for all the clay in the B as due to weathering; but I suspect that the original alluvium was more clayey on top. This is a very gently undulating old river terrace. This is said to be the main soil from the old Ganga alluvium.

We go on past the Rind River. There is some relief along the river because of drainageways. But soon we are on nearly level soil part of which is too wet and too salty for winter crops and is used only in summer for paddy.

We come onto Kanpur type No. 4, which is said to be really the halomorphic associate of Kanpur type No. 3. It is set up as a separate type I am told because there is so much of it! Part of the soil has a mild microrelief. It is covered with water in the monsoon, but the water table is said to be at 8 to 10 feet during the dry season. I am told that this soil is similar to the other halomorphic ones except with somewhat more of a claypan under the croute calcaire.

These 'soil types' are considerably broader than our soil series as defined in areas of fairly intensive use.

We eat a light lunch of sandwiches and bananas and return to Kanpur. Here all the cow dung seems to be used for fuel. It is made into elongated cakes. These are dried, heaped into mounds, and plastered to protect them during the rainy season. Kanpur is

Transitional 33 - 51" B₃
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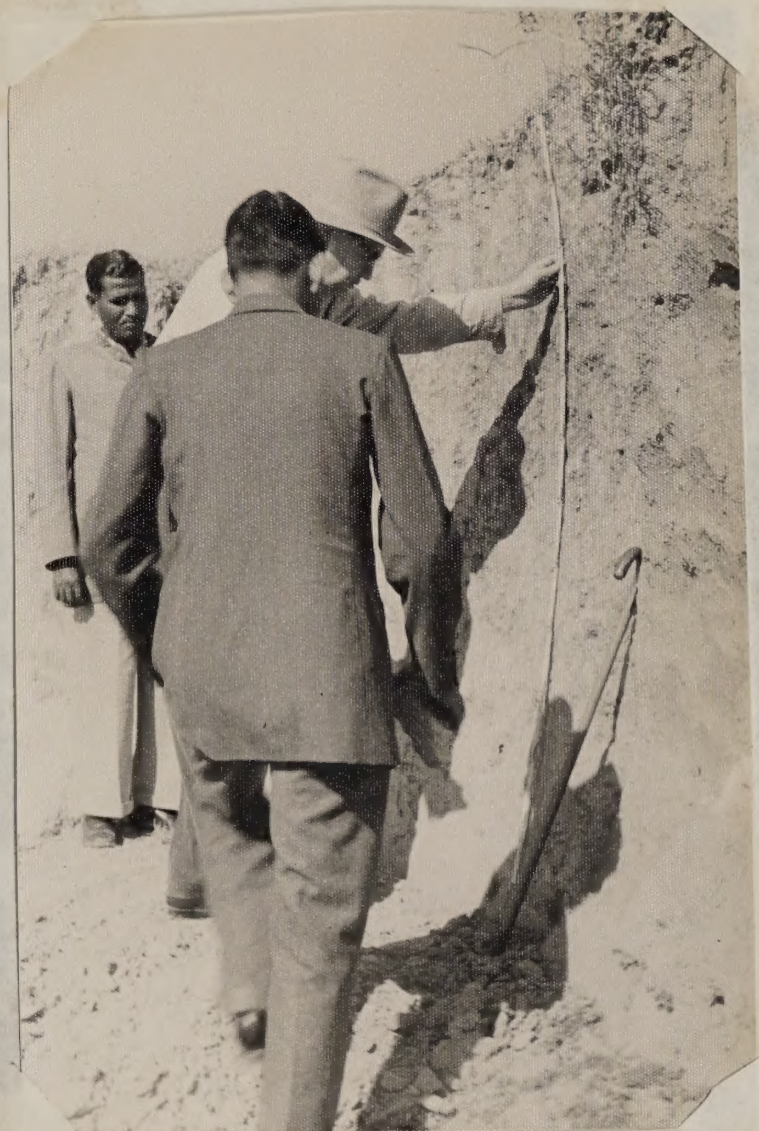
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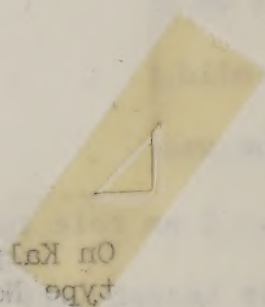
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On Kalpi Road, 12 miles west of Kanpur,
type No. 2. January 31, 1958. (S.P.R.)



21



On Kaji Road, 12 miles west of Kanpur,
Type No. 2, January 31, 1958. (S.P.R.)



K-2484. Near Kanpur. Pats of cow dung drying. To be used for fuel.

4.4

1142

K-248. Near Kanpur. Pats of cow dung drying. To be used for fuel.



On Kalpi Road, 16 miles west of Kanpur, type No. 3.
January 13, 1958. (S.P.R.)



On Kalpi Road, 14 miles west of Kanpur. Halomorphic phase
of type No. 2. January 13, 1958.

On Kelp Road, 14 miles west of Knapton, type No. 3.
January 13, 1958. (S.F.R.)

On Kelp Road, 14 miles west of Knapton. Heliozoan phase
of type No. 3. January 13, 1958.

not a very nice city. The streets are narrow and crowded with people, buffalos, bullock carts, bicycles, and rickshas. There are some heavy trucks but very few cars driven by Indians except for the old chauffeur driving for a European.

I stop at the hotel a few minutes and then go on to the laboratory at the agricultural college.

In the hotel gardens and in other gardens here many of the flowers are grown in pots so that they may be moved about. This is a nice way to arrange flower shows so long as there are plenty of boys available to carry them about.

Mr. Mehrotra takes me to the laboratory where I meet Dr. Agarwal, the head chemist. He tells me that they start their survey work with a reconnaissance that gives the main soil types. I can see that these soil types here are considerably more broadly defined than ours and the definitions are based a bit too exclusively on "typical" profiles.

Following the reconnaissance, a master legend with the necessary variants is developed for detailed surveys. They are using 147 men in all of Uttar Pradesh of whom 25 are soil scientists. The scheme employed is very much like that developed by the late C. F. Charter for the Gold Coast. I am shown detailed soil maps made on 16-inch-to-the-mile cadastral surveys. Traverses are laid out by the party chief and the field workers make soil profiles at regular intervals and fill out simple forms. These field workers are high school graduates with about two additional years of general agricultural training. Dr. Agarwal emphasizes the need to have the questions on these forms strictly objective. That is, they don't ask the boy

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whether the soil is hard or not, but whether he could get through it with an auger or had to use the pick. Then with these forms keyed to the map the survey party leader draws tentative soil boundaries in the laboratory on the field sheets. These boundaries are later checked by the survey party leader in the field and put in their final position. These maps are reproduced at the same scale for some uses; then reduced to 4-inches equal one mile; these to 1-inch equals one mile; and finally to 1-inch equals 4 miles for use to give a soil map of large districts.

I am shown a map of a State farm at 4-inches equal one mile. I can see that although the boundaries are supposed to have been sketched in the field, many follow the straight boundaries of holdings and part of these cannot possibly be right. Apparently this farm is a mechanized one on new land and will be operated somewhat like a collective.

Dr. Agarwal tells me that he feels that all mapping should be done by the States with published reports by districts. He refers to the constitution of India that emphasizes State responsibility for agriculture. He says he cannot visualize field mappers employed by the Center.

At the request of Dr. Agarwal I give the whole staff a discussion of our soil survey methods and program in the United States.

During the discussion Dr. Kahn comes in. He is in charge of the State soil conservation station and training center. I am told that his researches deal with State problems, while the studies of the Center deal with the common problems! Nobody tells me how they sort them out; and there is obvious duplication.

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Dr. Agarwal shows me monoliths of the alkali-saline soils with croute calcaire above a claypan. (For a discussion of these saline soils see papers by Dr. R. R. Agarwal in the Journal of Soil Science. 7:109:1956 and 5:300:1954).

For the consolidation of holdings I am told that the lands are first mapped out according to quality so that at the end of the consolidation a cultivator may have 3 or more parcels depending upon the number of kinds of soil that the village occupies.

For irrigation schemes and land reclamation, dependence is placed on the soil survey, but the old tax surveys are used for the consolidation of holdings although they admit that the soil survey would be much better.

Dr. Kahn is apparently making some kind of soil conservation surveys on and around the station separate from the soil surveys of either the Center or the State. His explanation shows that he is very badly confused about the relationships between soil characteristics and erosion hazard. In fact, he tells me that there is a direct correlation between erosion hazard and texture of the surface soil!' He tells me that in making soil surveys the men do not even examine the soil below the surface layer that is moved in tillage. Of course, this is ridiculous. He has been in the United States and claims he was trained by the Soil Conservation Service in this method. What a pity! Certainly he should not be running any kind of survey and least of all one based on only a few features.

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Fifty Years of Soil Survey Work in India*

R. R. AGARWAL

Department of Agriculture, Uttar Pradesh, Kanpur

This review does not take into account the voluminous, very useful and important work done in India on soil physics, irrigated soils and methods of soil analysis by Puri; on soil colloids and soil acidity by J. N. Mukherjee; on water logging, bio-chemistry and micro-biology of soils by Subrahmanyam; on nature of clay minerals by R. P. Mitra; on photo-chemistry of soils by N. R. Dhar and other soil work of both fundamental and practical importance by other well known Indian soil workers. Because of the personal acquaintance the author has with work on soil survey, soil classification and soil systematics, it is proposed to review only the work connected with this branch of soil research in India. This should, not, in any way, underrate the importance of other branches of soil research in India on which considerable time and energy have been spent by some of the first-ranking soil scientists of the country and in which results of far reaching importance have been obtained. Special reference may, however, be made of the fact which was first to be recognised by the soil workers of India, that of the prevailing and universal nitrogen deficiency of our soils. Evidently, the earliest researches on soils in India were directed towards elucidating the various nitrogen transformations that take place in the different soil-climatic regions of the country. These researches touched all aspects of soil nitrogen, *viz.*, nitrogen gains, nitrogen losses, levels of nitrogen and nitrogen economy and agronomic practices in the soil.

Scientific interest in the nature and the characteristics of Indian soils, in fact, started when the Indian Geological Survey was found in the year 1846 and the officers of that Department started studying the Indian soils from the geological and mineralogical angles. Perhaps, the word 'laterite' itself was coined in India by Buchanan (1807) in 1807 on his studying the geology of the south Indian soils. However, real research on the Indian soils, in so far as it relates to their characteristics, formation and management from agricultural or scientific points of view, started after Voelcker (1893) brought out his report on the improvement of Indian Agriculture in 1893. Leather (1898) distinguished four major groups of soils in India, *viz.*, the Indo-Gangetic alluvium, the black cotton or *regur* soils, red soils lying on metamorphic rocks and the laterites and the lateritic soils. Interest in soil survey and soil research originated in the agricultural departments of some of the bigger Indian States by the appointment of Agricultural Chemists in those States; but since no well-defined or clear-cut objectives of such a work could then be laid down, no real headway on a co-ordinated basis was possible and the entire efforts of over 20 years, in the first quarter of the present century proved to be somewhat futile. Even as late as 1928, the Royal Commission on Agriculture in India (1928), expressed the view that the main classes of Indian soils and their approximate location were reasonably well established and that little further was likely to be gained by large scale soil survey work in India, except for specific purposes in specific areas.

In attempting to present a connected picture of the entire work done on soils during the last fifty years, certain trends become very visible. These trends have, in fact, governed the very nature of soil work in this country. The development of the subject in the entire period of fifty years can be divided into the following four phases, to describe

* A paper read at the Symposium on Agricultural Research on the occasion of the Golden Jubilee Celebrations of the Indian Agricultural Research Institute, New Delhi in April, 1955.

the more important developments that have been achieved so far. These phases are : (i) pre-1928 phase which dominated the pure chemical concept of the soil, (ii) the second (1928-1938) phase in which purposeful soil surveys were done; (iii) third (1938-1947) phase which brought in the concept of soil genetic factors in soil survey work and (iv) the post-independence phase which saw an era of intensive soil surveys.

Pre-1928 phase

When attempts were made to introduce the scientific methods for the improvement of Indian Agriculture in the beginning of the present century, soils and crops were the two major items that attracted the attention of scientific workers throughout this country. In the earliest phase of soil research in India one meets with a great diversity of thought and work, specially as the first State Agricultural Chemists, who were responsible for such work had varying degrees of interest in the different aspects of the then ill-defined soil science. But in the matter of soil survey and soil classification, Madras can undoubtedly be considered as the pioneer state in India to have taken up large scale soil surveys with a view to obtain knowledge of the nutrient status or the so called manurial requirements of the soils. Many soil survey reports have been published by the Madras Department of Agriculture by Harrison (1914; 1915), Norris (1922) and Viswanath (1915). Simultaneously, the Indian Tea Association were conducting soil surveys of the tea soils of Assam, reports of which have been published by Carpenter and Cooper (1922; 1924) and Carpenter and Harler (1924). Lander (1929) published a very lengthy account of the soils of the Punjab and Sahasrabudhe (1929) that of Bombay State. These important and pains-taking researches which were mainly chemical soil surveys on which perhaps large amounts of money were spent, showed the diverse, or even the impossible, nature of such a work and helped to further confuse an already confused subject in India. Since the work failed to give adequate information of agronomic value for our agriculture, the soil workers of pre-1928 period had grave doubts if their soil analyses and soil survey were really going to be of any material use.

The Second phase (1928-1938)

In order to prove the usefulness of their work to practical problems Indian soil workers, after 1928, directed their attention towards soil surveys in connection with irrigation projects. This marks the beginning of the second phase of modern soil research extending roughly from 1928 to 1938. Broadly speaking, at the beginning of this period, the soil workers felt that their earlier attempts had not been fruitful, at least to the extent they had hoped they will. The Royal Commission on Agriculture had expressed the view that large-scale soil survey in India may be taken up for specific purposes in specific areas. Two items of broad significance interested the soil workers of this period. The soil surveys and soil work in connection with irrigation projects and soil work in connection with cash crops like sugarcane. Both these problems were of great practical significance to Indian agriculture. Introduction of large scale irrigation projects had created salinity and soil deterioration problems in the Punjab and the Bombay Deccan; and sugar industry was trying to establish itself in the country. The work connected with these projects proved to be of a definite advantage over that contemplated earlier with nutrient or manurial surveys, since the soils in these later studies were examined to much greater depths, than in the former, and soil characters like drainage, soil reaction, exchangeable bases and profile location of clay or soluble salts accumulation came in the forefront. Thus, from the purely chemical concept of the soil in the pre-1928 period, this period marks the beginning of the importance of the physico-chemical and profile characters of the soil, which in fact gave a better understanding of the soil in relation to the application of water or plant growth. Important researches in this connection were conducted in Madras, Mysore, Punjab and

Bombay. Mention may be made of the soil surveys of the lower Bhavani, Cauvery-Mettur, Tungabhadra, Toludur and Gundala Kamma project areas described by Ramiah (1935; 1936; 1937; 1938); and of the Irwin canal area in Mysore described by Iyenger (1930). In the Punjab (1932; 1935) extensive soil surveys were done in connection with the irrigation schemes for Haveli and the lower Chenab projects. Other work of importance emerged from the Punjab Irrigation Research Institute. Similar work was done in the Bombay State in connection with their major canals.

However, the work described above, which was of an utilitarian value, failed to see the soil entirely in its proper perspective and as an independent natural body, reflecting in itself the forces of soil forming factors, till Basu (1938) in 1938, published the results of his important work, carried out at the Padegoan Sugarcane Research Station from 1932. He followed the genetic system of soil classification originally developed by the Russian Pedologists and so successfully adopted for their needs by the American and European soil scientists. Previous to Basu's work, some information on the genetic characters of the soils of the typical areas in India was known. For example, Harrison and Sivan (1912) had done some preliminary work on black cotton soils and Bal (1935; 1936) had similarly given out some aspects of similar soils in Madhya Pradesh. It was known that the silica-sesquioxide ratios of the black soils derived from different parent rocks were unusually constant and that the ratio was higher for the black soils in comparison to the reds, when the two occur continuously. Besides, the publication of the book by the Russian pedologist Schokalsky (1932) on the natural conditions of soil formation in India, did much to stimulate logical thinking and systematic pedological research in the various broad soil groups in India.

The Third phase (1938-1947)

In the later part of the second period, our ideas on soil surveys and soil classification were greatly influenced by the deliberations of the International Soil Science Society held at Oxford in 1935 and by the two meetings of the Crops and Soils wing of the Board of Agriculture in India held in 1935 and 1937. The third phase of soil research in India which covers the period from 1938 to 1947 can be called the period of genetic soil work. A better description for this may perhaps be the period of high endeavour and concerted soil work in limited areas. It was in this period of high endeavour that detailed information on scientific lines became available on our main broad groups of Indian soils, viz., the black cotton soils, the red and lateritic soils and the alluvial soils. The well known Russian concept of soil-forming factors in the soil genesis and soil-classification came to be recognised and applied by the Indian soil scientists to Indian soils. The soil was pictured to be the product of the action of climate and vegetation upon the parent material as conditioned by the local relief and the time during which these forces have been in operation. Thus, as in other countries, the period marks the beginning of the true science of the soil in India. Basu had the ideal opportunity as he was working on the soils of residual origin, an opportunity which was denied to his contemporaries in the alluvial tracts where horizon differentiations are not so clear cut or visible to naked eye. Basu was able to differentiate the soils of the Deccan Canals in accordance with morphological, physical and chemical properties of the different horizons as affected by topography. He distinguished between soils formed under free and impeded drainage and between high-level shallow, low-level shallow and low lying deep soils. He called these soils immature tropical chernozems. Almost at the same time in the Punjab, MacKenzie Taylor (1936) and his associates were studying the soils in hill areas of the Kulu Forest where profile study of the soils revealed them to be the tropical counterparts of the podsolie group. Similar work conducted later by Mukerji

and Das (1940) in the Kumaon Hill soils of Uttar Pradesh showed that a consideration of the genetic factors in soil survey work can lead to a better understanding of the soil both in regard to their characteristics as well as management. Four types of soils were distinguished in the Kumaon Hills *viz.*, Podsol, brown-forest soils, Wissenbodens and red loams. This study, as well as that initiated by MacKenzie Taylor, brought out prominently the effect of parent material, vegetation, relief and maturity on soil development under the temperate climate obtainable in our Hill areas. Work in other areas followed rapidly. Subsequently, studies on the Bundelkhand soils of Uttar Pradesh (Agarwal and Mukerji, 1940), Hyderabad soils by Desai (1938) and Coimbatore soils by Raychaudhuri (1943), did much to elaborate the findings of Basu and to put the entire position of the Indian black cotton or *regur* soils on sound scientific footings. Thus, as in other countries, soil science in India was borne in the Chernozemic and podsollic regions of the country.

Besides, considerable morphological, chemical and mineralogical data on soils were produced during 1938-1947 on the more important groups of Indian soils. For example, voluminous work was done at the Dacca University on red and lateritic soils of India by two groups of workers, namely Sen (1941) and associates and Raychaudhuri (1940) and associates. Evidence was produced to show the chief morphological, chemical, physico-chemical and mineralogical characters of the red and lateritic soils which form an important group of Indian soils. However, the agronomic side of this work was not simultaneously investigated and hence the practical aspect of this problem yet remain to be elucidated.

During the same period, systematic work on the soils of the Gangetic alluvium grew up in Uttar Pradesh. It was shown that the soils of the Gangetic alluvium are not alluvial soils, in the sense they are understood in foreign countries. That the older alluviums show the effects of soil forming factors, although not to the same extent as in other groups, came to be recognised. Perhaps, the Gangetic alluvial soils can better be described as soils on alluvium. Evidence in this direction was obtained by the Uttar Pradesh soil workers when intensive soil studies were started in two distinctly different soil-climatic areas. The soils of the Unnao and Hardoi districts (Mukerji, Agarwal and Mukerji, 1946; Mukerji and Agarwal, 1947) formed on Gangetic alluvium in Central Uttar Pradesh under the semi-arid climate exhibited clear evidence of salinization and de-salinization as the main soil forming processes, as influenced by topography; whereas in the sub-humid tract of Gorakhpur, (Agarwal and Mukerji 1951) calcification and decalcification came out to be the prominent soil forming factors. The work in the later district clearly showed that topography is decidedly the factor which determines the genesis and the development of these soils. Three types of soils, *viz.*, soils with precipitated calcium throughout the profile, soils with a zone of calcium accumulation in the bottom of the profile and soils free of calcium were found to be distinctly associated with three phases in the toposequence of the entire landscape. Thus, it was proved that under Indian conditions it is possible to classify soils on the catena concepts, originally developed by Milne and adopted for their needs by the workers in the U.S.A. The ideas on genetic soil sub-groups, the classificational soil series, soil types and soil phases as adaptable for conditions existing in the Gangetic alluvium of Uttar Pradesh thus gradually developed. Morphological and other characters of the soil profiles in the various categorical units were correlated with the geomorphological characteristics thus enabling field soil-mapping units to be conceived on scientific lines and much detailed soil mapping work was done for the benefit of the sugar industry of Uttar Pradesh Mukerji, *et al.* (1946). Perhaps, this work together with similar work in the Bombay-Deccan on sugarcane soils, was the first of its kind in India, where genetic soil

types were associated with clear cut-soil management practices and other factors connected with growth of crops. Stewart (1947), in his report on soil fertility investigations in India, commended this type of approach and emphatically wrote that it can be of real value for solving many problems of soils which are intimately connected with agronomic problems. Incidentally, it also shows how any detailed or large scale work on soils which is divorced from simultaneous crop studies and is done in complete isolation, is not likely to be of much help in the scientific development of Indian Agriculture.

The Post-Independence phase

In 1947, Stewart who was invited by the Government of India to report on the planning and future conduct of soil work in India, gave out his valuable report. This report did much to help the soil workers in India to strengthen their position and to expand their activities. The period also coincides with the Independence of India and the establishment of popular Governments at the centre and at the States. The Agricultural Departments in some States were in consequence reorganised and in other States considerably expanded. Along with this also began the expansion of the soil research activities in the various States. The Indian Council of Agricultural Research sanctioned Stewart's scheme wherein soil survey and fertilizer experiments on cultivators' fields were included in the States of Madras, Bombay, Bihar and Bengal. The U. P. Government (Agarwal, 1950) took up an extensive soil survey programme with its connected agronomic work at five regional stations in the State, to extend the useful work done earlier on similar lines in Gorakhpur district. The Government of Bihar have recently taken up a similar soil survey scheme on large scale in their State. Reconnaissance soil maps of many districts and detailed soil maps of other smaller areas are now available with many bigger states (Agarwal and Mehrotra, 1951; 1952; 1954). Assisted by the funds and equipments provided by the Technical Co-operation Mission of U. S. A., the Indian Agricultural Research Institute launched soil survey work in six regions which is now going to be supplemented with full-fledged regional soil correlation laboratories to be financed by the Centre in the broad soil groups of India. Thus, in this period from 1947, from intensive localised work we pass on to 1955 and to extensive large-scale work on soil survey in India. Detailed field soil mapping, examination of the soils, preparation of the soil maps, soil correlation, etc., are planned to be executed throughout the length and breadth of this country within the next 5 or 10 years, both through State as well as Central funds.

We thus come to the end of our story. Our achievements in the past appear splendid and our future seems to be full of hopes. But let us examine this question a bit critically and impartially. If we do so, some very pertinent questions come up prominently. We know that large scale soil mapping, soil examination and soil surveys are on the plan throughout the length and breadth of this country. Are we scientifically prepared to undertake such a task? Have we the necessary facilities and personnel to successfully operate or man the various projects? There is a lamentable trend amongst our present soil scientists to copy the methods developed in foreign countries since no methods of our own seem to have been worked out for all the tracts. This tendency specially when applied to the soil mapping work in the field, without properly understanding or developing our own system, is likely to lead us into difficulties. Kellogg (1949) admits that attempts to extend systems of soil surveys developed in the temperate regions into the tropics or the sub-tropics, can not be expected to be entirely successful. According to him, detailed field soil classification work in tropical regions must follow only after greatly increased soil research in selected areas. Have we the necessary information for our various great soil groups which may enable us to correlate combinations of soil characteristics, as

determined by detailed morphological studies in the field and chemical, physical and mineralogical studies in the laboratory, with the geomorphological characteristics of the landscape enabling us to fix our legends? Have we the necessary data to show what pattern the defined units of the lower categories, *viz.*, phases, types, series and families follow in the different areas of our great soil groups so that our field workers may judge the internal characters of the soil profile from purely external examination and simple field tests? Is it not a fact that soil has many profiles within a defined range of landscape and unless the entire pattern is understood, the model profile for the soil type can never be visualised? Have we established the scale of our base maps in the different regions to allow reasonable details for agronomic purposes? Do we know what grids to be followed in the intensively cultivated alluvial tracts and in the sparsely cultivated central Indian or southern states? In brief such and other questions baffle and limit the scope of work of a practical soil scientist in all parts of India. Accordingly, it appears that the time is more opportune for much detailed and systematic fundamental scientific work on soils from typical areas, rather than the diversification of the attempts and extending soil survey, soil classification or soil mapping in unknown regions for which adequate preliminary information on soils and their agronomic behaviour has not so far been built up. One seems to be in perfect agreement with Pendleton (1949) that soil mapping is still more an art than a science and if we do not have many artists of the capability and experience as visualised by Pendleton, or can not convert this art into science, we can never hope to have a picture which will not be free from major defects.

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SOILS OF KANPUR DISTRICT THEIR MANAGEMENT AND FERTILIZER PRACTICES

By

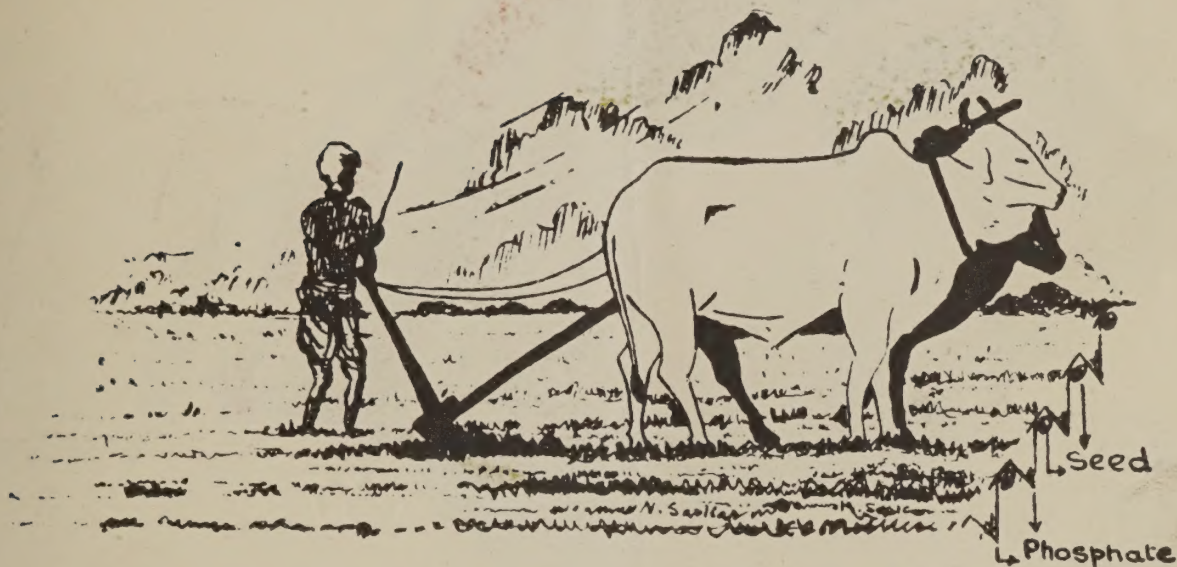
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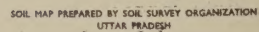
Soil Chemist



UTTAR PRADESH SOIL SURVEY ORGANIZATION, DEPARTMENT OF AGRICULTURE

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SOILS OF KANPUR DISTRICT THEIR MANAGEMENT AND FERTILIZER PRACTICES

By

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AND

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UTTAR PRADESH SOIL SURVEY ORGANIZATION, DEPARTMENT OF AGRICULTURE

D Alluvial soil

SOILS OF KANPUR DISTRICT

THE map enclosed with this booklet shows the distribution of broad soil associations of Kanpur district. These soil associations represent groups of soils having widely different genetic characteristics which are reflected in varying physical and chemical properties, such as colour, texture, drainage, relief, pH, lime contents and the maturity of the soil profiles. Each association includes soils of similar nature with only minor local variations which do not significantly influence their agricultural use. Such local variations could not be shown on this map, because of the difficulty in representing them on the map of this scale. The district contains in all six major soil associations. The main differentiating characteristics of these soil associations have been given in table I.

HOW TO USE SOIL ASSOCIATION MAP AND REPORT

A look at the map enclosed and with the help of the reference points such as roads, canals, rivers or rail road, the position of any village or area can be located. The colour shown for the area can be compared with the legend and thus the name of the soil association can be found out. The characteristics of the association as given here under can be compared with those found on the field. If these tally the manage-

ment and fertilizer practices to be followed for that type of soil can be carefully noted.

CHARACTERISTICS OF KANPUR SOIL ASSOCIATIONS

Kanpur type I (Recent alluvium)—This soil type is found on the recently deposited alluvial material from river Ganges and thus occurs as a narrow strip along side that river. The soils are still subjected to the influence of occasional floods and receive fresh deposits in very wet years. They are sandy to sandy loam in texture except for a few depressions where silty loam soils may be encountered at the surface. The soils are brownish grey to greyish brown in colour on the surface, the lower layers being slightly darker in shade. The clay contents are generally low and whatever clay is present is rich in exchangeable calcium, a factor which affords a rich source of readily available calcium to the plants. The soils are mildly calcareous with slight alkaline reaction. Small *kankar* nodules of the size of pea are occasionally found here and there in the lower horizons of the soil profile but with no typical formation. Ground water levels in the area being very high, considerable degree of salt efflorescence is observed specially in localities very near the river. At some distance from the river, the soils are free from this surface salt effect though even there the soluble salt

*this soil shows some local
low water*

contents may be fairly high. The features of horizon differentiations in the profile are not very distinctly marked. Brown specks and streaks are noticeable in the lower horizons of the soil profile.

Kanpur type 2 (Ganga lowlands)—This soil type occurs at slightly elevated levels and is completely outside the fluvial action of the river. The soil column shows evidence of profile development and horizon differentiations are visible. The soils on the surface are grey to dark grey in colour while the lower layers attain a yellowish_A tinge. The texture of the surface soils is finer than that of type 1 soils and varies from loam to clay loam being always underlain by a heavier subsoil. Whereas, the profile of the previous soil type is uniformly rich in lime these soils have little free calcium at the surface but the lower layers are rich in this component. Small calcium incrustations in the form of *kankar* nodules can be found in the bottom of the soil profile. Due to their finer texture these soils exhibit signs of impedance in the free movement of water and therefore are occasionally water logged during the monsoon periods. Iron mottling and small nodules are very commonly found in the lower horizons of the soil profile. The soluble salt contents are average to high but the exchange complex is saturated with calcium to the extent of 80 percent. The pH value of the soils is neutral at the surface but increases slightly in lower depths.

In depressional pockets in the otherwise flat landscape occupied by this soil type considerable degree of salinity and alkali is met with. It is in this area that about one third of usar acreage of the district is found. The characteristic features of usar land on this type are widespread salt incrustation, a barren look, poor internal or external drainage and an indurated clay pan in the subsoil. *Crust calcareous where shown to me.*

Kanpur type 3 (Ganga uplands)—The soils included in this type occur at the highest elevations of the district and have been formed from the oldest alluvium. They are characterized by a reddish-brown colour at the surface which darkens with depth and possess a coarse texture at the surface. The subsoils are heavier and show evidence of clay accumulation which has moved down from the surface. The soils are completely devoid of free calcium and even the clay complex has been depleted in this important constituent. Organic matter and nitrogen contents are very low. The soils in consequence are slightly acidic to neutral in reaction. The soils give the appearance of a highly leached and completely mature profile and represent the normal soil formation of the district. The region having this type of soil has excellent to excessive drainage due to the inherent nature of these soils and due to favourable relief. They are completely free of injurious water soluble salts. In general they are poor in plant nutrients and respond remarkably to fertilizer and

manurial treatments. They are thus very suitable for crop production under judicious crop husbandry and all crops, except paddy, do very well on these soils.

Kanpur type 4 (Central lowlands)—Within the elevated areas occupied by Kanpur type 3 soils innumerable depressions exist where the soils of this group are found. These soils have been formed due to the local influences of topography and relief whereby they receive washings from the surrounding high lying areas. They are thus of very fine texture in the upper regions of the soil profile, the lowest layers being lighter in texture. There is great variability of the profile depth, rather in the column of the layer deposited from the washings mentioned above. The colour of the soil varies from ash grey to grey throughout the profile the lower layers showing a bluish tinge due to water logged conditions. These soils are very rich in lime and generally have a layer of calcareous nodular deposit (kankar) which in severe cases of cementation may transform into massive rocks. The drainage of the area is very poor and throughout the rainy season present an appearance of continued water logging, occasionally covering miles and miles of area. There being no outlet for this water except evaporation dissolved salts accumulate and appear on the surface during dry periods. These salts being mainly carbonates and bicarbonates of sodium are responsible for high pH values of the soils and for bringing considerable degree

of soil alkalization. In stretches where alkalization is extreme, soils with as high a pH as 11.0 can be encountered. Such soils are saturated with sodium and remain deflocculated and puddled when wet and become extremely hard on drying. Mild degree of alkalization is also met within the area where drainage is not completely impeded and such areas can be successfully taken up for crop production under careful management. A typical feature of the profile in this area is the presence of large number of big sized iron nodules and brown and yellow mottlings scattered throughout the lower depths. Paddy seems to be the only crop which can thrive excellently under these soil conditions. The vegetation otherwise is very scanty.

Kanpur type 5 (Yamuna flats)—The soils grouped under this type differ greatly from the soils described earlier in so far as the parent material is concerned. These soils have been formed on the alluvium deposited by river Yamuna and show much resemblance to the Bundelkhand type of parent material. These soils are grey to dark grey in colour at the surface and are always underlain by a dark coloured subsoil which invariably contain a kankar pan. They are of very fine texture, the clay contents sometimes reaching as high as 50 percent, the coarse fractions being very little. The reaction of the soils vary from neutral to slightly alkaline. In spite of the fact that a kankar layer is found in the subsoil of this type, the drainage is not impeded

due to the excellent structure of the soil and accordingly there is no salt problem. The soils possess a potent reserve of plant nutrients and are productive under good management. Paddy forms the major crop of the area during kharif and pea and *bejhar* during rabi.

mango *"pigeon pea"*
Kanpur type 6 (Yamuna uplands)—At the south westerly extremity of the district adjoining the Yamuna river where the latter flows in a south easterly direction black coloured soils of this type resembling the *mar* soils of Bundelkhand are found. These soils are very fine textured throughout the profile and show no differentiating horizons. They are calcareous due to the presence of finely divided calcium carbonate but concretions are practically absent. The reaction of these soils is slightly alkaline, the pH value ranging near about 8. The soils exhibit many physical properties common to the black cotton soils such as swelling when wet and forming big crack and fissures when dry. No salinity or alkali problem is met with in this soil area. They can afford both kharif and rabi crops.

Broad differential characteristics of different soil types of the district are presented in table I.

FERTILIZER REQUIREMENTS OF KANPUR SOILS

Soils differ widely in their fertilizer requirements and whereas a particular soil responds only to nitrogenous fertilizers the other may need more of phosphates.

It thus becomes necessary to know what fertilizers should be applied and on which soil and crop. The important utility of soil mapping and characterization of different soil types lies in evolving the requirements of fertilizers for different soils together with the management practices for individual soil types.

This object has been achieved in Kanpur district through field experimentations on cultivator's fields as well as state farms in different soil regions of the district. Large number of experiments conducted both on kharif and rabi crops have shown that the nitrogen is the universal requirement for all crops and soil types, and phosphate requirement is specific only to soil types. Contrary to the belief held upto now it has been found that phosphate application to the phosphate deficient soils proves highly beneficial both for crop yields and building up of the soil fertility. This response however is only obtained if phosphate fertilizers are placed deep in bands at depths varying from 3 to 4 inches and only in the presence of adequate nitrogen.

The technique of phosphate placement has been evolved and simplified by the State Soil Survey Organization and has been found to be easily adaptable by the cultivators. This consists of a long stem funnel shaped attachment fixed behind a plough such that the phosphate when dropped through the funnel may lie in concentrated bands at depths varying from 3 to 4

TABLE 1. BROAD DIFFERENTIAL CHARACTERS OF KANPUR SOILS

Particulars	Ganga alluvium.				Yamuna alluvium.	
	Kanpur type 1 Recent alluvium	Kanpur type 2 Ganga lowlands	Kanpur type 3 Ganga Uplands	Kanpur type 4 Central low lands	Kanpur type 5 Yamuna flats	Kanpur type 6 Yamuna Uplands
Colour ..	Grey	Dark grey	Reddish brown	Ash grey to dark grey	Dark grey to grey brown	Dark grey to grey brown
Texture ...	Sandy to silty loam	Loam or clay loam	Sandy loam	Clay loam to loam	Sandy loam to loam	Loam to clay loam
pH ..	7 to 8	7 to 8 and above	6.2 to 7.4	7.2 to 8.8	6.6 to 7.8	7 to 8
Lime ...	3—4 percent throughout	Less than one percent; more at the bottom	Less than one percent throughout	Average to high	Average to high	Average
Clay ...	Poor	Average to high	High in sub-soil	Very high	Moderate, some illuviation	Average to high, no illuviation
Soluble salts.	High	Average to high	Poor	Highest in the district	Average	Poor
Drainage ...	Imperfect	Fair	Good	Very poor	Fair	Average
Average base saturation	86	81	70	64 in cultivated soils and 28 in uncultivated soils.	84	78
Concrétions	Ill-defined	Prominent	Absent	Kankar present	Kankar present in subsoil	Absent

Also has Halomorphite

inches below the surface of the soil. Since an ordinary desi-plough may not open furrows to this depth two desi-ploughs running in the same furrow, one behind the other, may serve the purpose; or occasionally an iron plough which can create deeper furrows would prove more effective. The phosphated bands are covered up with soil by drawing over a pata and the seed is sown in lines behind another desi plough between two consecutive bands of phosphate. Thus the root system of the plants can obtain its phosphate requirement from either side. Nitrogenous fertilizers may be applied broadcast after the phosphate application.

In the experiments conducted by the organization the doses of nitrogen and phosphoric acid were fixed at an economic level keeping into consideration the value of the foodgrains. Thus for *kharif* crops consisting of coarse grain like jowar and bajra the levels were kept at 15 and 30 lb nitrogen as ammonium sulphate and phosphoric acid as single superphosphate per acre respectively. In case of *rabi* crops these doses were doubled. The results obtained from large number of these trials with different crops on agriculturally more important soil types of the district are given in the table II. For this study Kanpur type 5 and 6 were not taken up due to the fact that irrigation is sparsely available in those areas and without this fertilizer application does not prove beneficial. In the table

have been shown the percentage increase due to the nitrogen and phosphoric acid over control with different crops and soil types. The economics of the fertilizer application have also been shown in table.

It would be seen from the table that phosphate application is universally profitable in Kanpur soils except for the jowar crop on type 1 soils. This response is specially remarkable in Kanpur type 3 and 2 soils where the application has proved profitable to very great extents. In these soil types with *rabi* crop viz., wheat the return per rupee of phosphatic fertilizers in the form of crop produce is more than double. With *kharif* crop in general immediate gain with phosphates, though profitable, is not very remarkable. The response from nitrogenous fertilizers is of a very high order specially in wheat crop. This again is more pronounced in type 3 soils. *Kharif* crops have not shown very encouraging results with nitrogenous fertilizers and in type 4 soils there is actually a loss in the net return. On the whole it can be concluded that type 3 soils should universally receive both nitrogenous and phosphatic fertilizers. Phosphatic fertilizers need not be taken up on type 1 soils and only moderate doses of phosphate be applied on type 4 soils. Fertilization on *kharif* crops is not a very profitable proposition.

Besides the increase in yields shown by the

TABLE II. INCREASE IN CROP YIELDS AND ECONOMICS OF FERTILIZER PRACTICES IN RELATION TO IMPORTANT SOIL TYPES OF KANPUR DISTRICT.

Soil type.	Crop.	Number of trials,	Treatments.			Increase per lb. of fertilizing ingredient		Additional food grain in lb per rupee worth of fertilizer		Return from one rupee worth of fertilizer			Profitable or not.				
			C	N Percent	N+P					N Rs. a. p.	P Rs. a. p.	Nitrogen.	Phosphate.				
Kanpur type 1	Jowar.	9															
	Grain.	...	100	127	144	7.8	2.2	9.9	4.4	1	2	0	0	10	0	Marginally profitable	Not profitable
	Stover	...	100	118	132	51.0	19.2	58.0	38.4								
	Wheat.	12															
Kanpur type 2	Grain	...	100	117	130	4.7	1.8	5.4	3.6	2	1	0	1	3	0	Highly profitable	Profitable
	Stover	...	100	130	148	24.5	6.9	28.0	13.8								
	Wheat	15															
	Grain	..	100	121	144	7.1	3.7	8.1	7.4	1	2	0	1	5	0	Marginally profitable	Profitable
Kanpur type 3	Stover	..	100	115	141	55.0	47.4	63.0	94.8								
	Wheat	22															
	Grain	..	100	120	145	6.0	3.9	6.9	7.8	2	2	0	2	4	0	Highly profitable	Highly profitable.
	Stover	...	100	120	141	18.4	9.7	21.0	19.4								
Kanpur type 4	Jowar.	18															
	Grain	..	100	138	166	10.7	4.0	12.2	8.0	1	15	0	1	4	0	Highly profitable	Profitable.
	Stover	..	100	137	164	106.0	39.5	121.0	79.0								
	Wheat	19															
Kanpur type 4	Grain	...	100	124	140	10.1	3.5	11.5	7.0	4	1	0	2	1	0	Very highly profitable.	Highly profitable.
	Stover	...	100	130	144	41.4	9.6	47.3	19.2								
	Jowar	6															
	Grain	..	100	122	150	2.8	4.3	3.2	8.6	0	8	0	1	1	0	Not profitable	Marginally profitable
Kanpur type 4	Stover	..	100	115	139	32.0	27.5	37.0	55.0								
	Wheat	8															
	Grain	..	100	116	124	6.5	1.7	7.4	3.4	2	5	0	1	4	0	Highly profitable	Profitable
	Stover	..	100	126	146	19.5	7.9	22.3	15.8								

Note — 1. Prices calculated on the market rate prevailing viz., in December 1954, wheat at the rate of Rs. 16 Bhusa at the rate of Rs. 3 per maund; Jowar (grain) at the rate of Rs. 5/10/- and straw at the rate of Rs. 12/a maund.
 2. Prices of nitrogenous and phosphatic fertilizers worked out from the market rate of ammonium sulphate and super phosphate (single). Nitrogen at Rs. -/14/- a lb. and phosphate at the rate of Rs. -/8/- a pound.

= 82.3 lbs

phosphatic fertilizers on the first crop, this fertilizer has been found to possess another advantage in the way that it leaves a lasting influence and considerable degree of response is obtained from the same field on the succeeding crops. Experiments conducted by the organization have shown that the residual effect of phosphatic fertilizer is obtained in at least two succeeding crops where significant increased yields have been recorded. Since nitrogenous fertilizers have not been found to leave much residual effect their application becomes necessary with each crop. In residual effect studies a basal dose of nitrogen at the rate of 15 lb. Nitrogen per acre in the form of ammonium sulphate has been given to the subsequent paddy crop after wheat and no nitrogen applied in the third crop which happened to be a legume viz., gram. The increase in paddy crop and the subsequent gram due to residual phosphate has been found to be of the order of about 60 and 40 percent respectively of the initial response on wheat. It can, therefore, be concluded that nitrogen is the requirement for all crops but phosphoric acid is actually a soil requirement. The practice of phosphate application every third year in phosphate deficient soils will thus have a permanent soil building effect.

MANAGEMENT OF KANPUR SOILS

Amongst the more important prerequisites towards the management of soils of this district supplies of moisture and plant food elements are extremely

essential. Maintenance of adequate soil moisture means the provision of supplemental irrigations where it is urgently needed, or adopting dry farming practices for crop production where irrigation is not feasible and afford adequate drainage in areas where water stagnation is a severe problem specially during monsoon months. This control of water considerably helps in checking the serious depletion in soil being brought out as a result of slow soil erosion thereby losing its potential fertility. Even though severe slopes are not very common in the district, long and continuous rains may slowly remove the productive top soil in the form of sheet erosion. Such erosion losses should be minimised by adopting control measures such that surface run off may be eliminated. Unjudicious use of irrigation water without provision of adequate drainage frequently brings out problems of soil salinity.

(cultivated dry)
Soils of Kanpur district, like all tropical soils, are very poor in organic matter, a good supply of which is of fundamental importance to crop growth. Organic matter increases capacity to hold water, improves soil tilth, lessens erosion and affords an excellent supply of plant food. In any programme of good soil management of the district this should therefore, be given greatest emphasis. Usual methods for achieving this objective are (i) use of bulky organic manures such as farmyard manure compost etc. (ii) adoption of suitable rotational practices where in leguminous crops may be

TABLE III. MANAGEMENT PRACTICES FOR AGRICULTURALLY IMPORTANT SOIL TYPES OF KANPUR SOILS

Particulars	Kanpur type 1	Kanpur type 2	Kanpur type 3	Kanpur type 4
Erosion control	If slopes are very steep, bunding of the fields and contour cultivation may be adopted.	No major problem	Slow sheet erosion. Vegetable soil cover may be maintained.	No problem
Drainage	Drainage may be a problem due to the prevailing high water table. At times even flooding of the fields may take place and may constitute severe problem.	Drainage is a serious problem in depressional areas which results in considerable alkalization.	No problem	Drainage is a problem due to excess alkali. A planned drainage system for taking out surplus water is necessary. Use of gypsum at the rate of 1 to 3 tons per acre may prove extremely beneficial.
Irrigation	Irrigation from wells may be adopted with advantage.	Irrigation both from wells and canals usually highly beneficial.	Irrigation both from wells and canals usually highly beneficial.	Irrigation to be done with caution since salinity may increase if drainage is defective.
Where irrigation is not possible adopt dry farming practices: (i) use reduced seed rate and increased spacing (ii) interculture between rows to eliminate weeds.				
Crop Rotation	<i>Dhaincha</i> as a green manure may be taken once every three years.	<i>Sanai</i> or <i>dhaincha</i> may be taken once every two years.	<i>Sanai</i> or <i>moong</i> or <i>lobia</i> may be taken frequently.	<i>Dhaincha</i> may be introduced.
Organic matter	Plentiful supplies of bulky organics: green manuring and adoption of rotations having leguminous crops necessary.			
Summer ploughing	Plough the fields immediately after rabi harvests			

TABLE IV. FERTILIZER RECOMMENDATIONS

For Agriculturally important soil type of Kanpur.

AFTER RABI HARVEST.

Particulars.	Kanpur type 1.		Kanpur type 2.		Kanpur type 3.		Kanpur type 4.		Remarks
	N	P	N	P	N	P	N	P	
Kharif									
Paddy ..	30	...	30	..	..	...	30	..	{ Paddy is not responsive to P applications.
Jowar }	15	15	15-20	25-30	20-25	30	15	20	
Bajra }									{ Only residual effects be utilized.
Maize ...	Not grown.		50-60	...	50-60	...	...	..	
Arhar ...	..	...	..	..	...	..	..	..	{ Arhar and maize are very deep rooted crops and do not respond to P fertilizers.
Rabi									
Wheat }	20	30	20-30	20-30	25-40	30-40	25	30	{ Gram, pea and berseem being leguminous meet their N requirements from the atmosphere through bacterial fixation.
Barley }									
Gram ...	...	20	...	20	..	30	...	20	{ No additional N is required.
Pea ...	..	20	..	20	...	30	..	...	
Berseem ..	...	..	..	20	..	30	...	30	
Sugarcane ..	50	60	50	60	60	80	50	60	
Potatoes ...	50	60	50	60	60	80	...	..	

grown in rotation both in *kharif* and *rabi* harvests and (iii) the introduction of suitable green manuring practices.

Amongst the tillage practices, summer ploughing just after the *rabi* harvest considerably raises the fertility status of the soils. Long term rotational experiments conducted by the State Soil Survey Organization have shown that the *rabi* produce is increased to the extent of 10 to 15 percent through this practice in comparison to the prevalent practice of fallowing. The management practices in general

have been summarized in table III. Specific recommendation in respect of fertilizer requirements for individual soil types are given in table IV.

RECLAMATION OF WASTE LANDS.

Reclamation of waste lands specially those of saline and alkali type (usar lands) is an intricate problem and needs special attention and guidance. An excellent Soil Advisory Service exists under the State Soil Survey Organization to render advise on problems of management and reclamation of soils. State Agricultural Chemist, Kanpur may be contacted in this respect.



RAVINE-INFESTED AREAS IN AGRA

U.S. Soil Expert's Visit

From Our Agra Office
JAN. 17.—Dr. C. E. Kellogg, an eminent Soil Scientist of U.S.A. and Chief of the Soil Survey, Department of Agriculture USA, who is on one month's tour of India, paid a visit to Agra on Jan. 11 accompanied by Mr. Nixon, T.C.M. expert and Sri Rama Rao, Director of Soil Conservation (Engg.), Government of India, to see the ravine-infested areas on the bank of Jamuna and the Pilot Project on Ravine Reclamation work at Chalesar about eight miles from Agra.

Dr. Kellogg and the party were shown round by Sri A. B. Phadke, Soil Conservation Officer, Agra. Dr. Kellogg was much surprised by the damage ravines have caused to the erstwhile fertile lands and appreciated the vastness of the problem and efforts that are being made to combat the same. During the discussion valuable suggestions have been made by Dr. Kellogg to improve the soil of such eroded areas.

Three-fold Rise In Indian Farm Yield Envisaged

U.S. EXPERT URGES PROPER SOIL CONSERVATION

FROM OUR CORRESPONDENT

DEHRA DUN, Jan. 11.

DR C. E. KELLOGG, head of the Soil Survey Division of the U.S.A., said at a Press conference here that if proper soil conservation practices were applied to land in India, production could be increased three to four times to solve the food problem of the country.

Basing his impressions on the land between Delhi and Dehra Dun in Western U.P. which he visited since his arrival here a week ago, Dr Kellogg suggested improved water supply, better tillage to maintain soil in good condition, use of organic matter and fertilizers (phosphate and nitrate) and gardening in areas with trees, avoiding over-grazing and gradual cutting of forests for timber needs.

Referring to shifting cultivation, he said: "It is difficult to stop this in view of non-availability of sufficient land for the large population. But things can be improved by growing a particular crop for only two or three years, then allow forests to grow and till another strip on the contour. This will help maintain the soil and also the required area under forest."

Dr Kellogg referred to unnecessary wastage of land by brick-kiln owners in India. He said these had been carelessly dug out, wasting fertile agricultural land. They should dig two or three ft. deep and then dig further deep instead of taking more area for cheaper digging. They should conveniently dig up to 12 or 15 ft. "What they should not do is that they should not spoil vast areas and leave them unproductive."

Dr Kellogg is on a five weeks' tour of India at the invitation of the Union Government. He went round the soil conservation farm experimental centre and addressed officer-trainees. Dr J. K. Basu, Director Soil Conservation, accompanied him.

Ravine Reclamation Work In Agra

U.S. SCIENTIST'S APPRECIATION

FROM OUR CORRESPONDENT

AGRA, Jan. 20.—Dr E. Kellogg, chief of Soil Survey, Agriculture Department, U.S.A., who is on a month's tour of India, visited Agra, accompanied by Mr Nixon, T.C.M. expert, and Mr Rama Rao, Director of Soil Conservation (Engineering), Government of India, to see the ravine-infested areas on the Jumna and the Pilot Project on ravine reclamation work at Chhalesar, eight miles from here. The project is sponsored by the Government of India to find out the causes of ravine formation and to suggest remedial measures for their economical reclamation.

Dr Kellogg and party were shown round by Mr A. B. Phadke, Soil Conservation Officer, Agra.

Dr Kellogg saw the damage the ravines had caused to the fertile lands and appreciated the vastness of the problem and the efforts that were being made to combat it. During the discussion valuable suggestions were made by Dr Kellogg to improve the soil.

Although they have some serious limitations I am convinced that the surveys made by Dr. Agarwal's group on the 16-inches-to-the-mile maps are very much better. Without a recognition of the basic soil type no soil survey would be of any use for conservation planning, because the most important features are beneath the surface soil. We have quite a discussion of this matter that everyone seems to understand perfectly except Dr. Kahn. The discussion stops about 6:30 p.m., and I return to my hotel after a long day.

Dr. Agarwal impresses me quite favorably. Since the 16-inch-to-the-mile maps are available and since there are very, very few trained soil scientists, I believe that his grid system is a better arrangement than mapping as we do on 4-inch-to-the-mile air photographs. A soil map here to help the cultivator must be accurate in respect to each of the tiny holdings. I hope that he may be able to come to the United States. Perhaps he is the outstanding man in India for this work. I am still amazed at the very close parallel between his system and the one developed by Charter in the Gold Coast.

January 14: I have tea and pack for my journey. I have breakfast and go out again with Dr. Kahn, Dr. Agarwal, Mr. Satyanarayana, Dr. Raychaudhuri, and Mr. Mehrotra. Part of the group are late so we don't actually leave for Lucknow until 9:10. Their excuses are that the streets were so terribly crowded because of people going down to bathe on this religious day in the Ganga River. On this day the sun moves from the southern to the northern hemisphere.

This is said to be a holiday in all Uttar Pradesh.

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With the staff of the State Agricultural Chemist. Dr. Agarwall at Dr. Kellogg's left. January 13, 1958.



Between Kanpur and Lucknow. Afforestation of "Usar" land. L. to R: Satyanarayana; Charles E. Kellogg; Dr. Agarwall; Kuan; Mehrotra.

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With the staff of the State Agricultural Chemical. Dr. Agnieszka
Dr. Dr. Kojan's left. January 15, 1958.

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Between Kagan and Luchkov. Attestation of "user" Jan.
that the L. to R. Baryshnikov; Charles R. Kojan; Dr. Agnieszka;
Khan; Mehrotra.

(Added later: This must not be quite right because I did not see crowds everywhere).

As we start for Lucknow we pass through streets terribly crowded with people, along with cows and buffalos. As we go near the river I see some people bathing despite the water being very cold.

After crossing the river we are in an ill-drained area that is sometimes flooded. It has a strong microrelief from old diggings. I hate to see this wasteland used only as rough pasture because it could be developed rather simply with some works for protection and drainage. As we drive on the soil gradually improves and some parts are used for crops. At about 4 miles from the bridge we come to the old bank of the river and Kanpur soil type No. 2. Here there are more trees and most of the land is in crops. There is some relief because of mild dissection, and erosion hazard on slopes. Part of the slopes have earth bunds for runoff and erosion control. Unhappily, these are not so well designed as they could have been with accurate soil boundaries as guides. As we drive on I see considerable irrigation. Here the water is raised from shallow wells by a large bowl-like bucket with a chain on either side handled by two men. The two men drop the bucket in the well and heave it out together. I notice a lot of waste from digging for brick material along here. We pass an abandoned sugar mill.

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We pass Unnao, a district headquarters some 14 miles north-east of Kanpur. There are some very poor mud huts in this area said to be occupied by people of the low caste, who are not permitted within the town.

We go over a large area of white saline soils. Some parts are used for paddy but much is only rough pasture. These are called the halomorphic phase of Kanpur type No. 2. I am told that the new high road grade has greatly worsened the drainage. It should not be very difficult to drain this area and make it suitable for cropping. Here and there one does see small, very slightly elevated areas used for crops.

We stop to look at an attempt at reforestation on this alkali-saline soil. Agarwal thinks that drainage would be difficult but I don't believe it would be very hard to do. The trees are not doing well. In places the crôte calcaire (or kankar pan) comes out almost to the surface and is mixed with some iron concretions. Agarwal tells me that a kankar nodule starts around a silica particle. Here there are iron-manganese concretions below the kankar layer. This kankar layer is not permeable to roots. When moist areas become dry they have a black thin scum on the surface. Even on gentle slopes there is said to be some erosion because of this Solonetz-like thin crust. Particles of white sodium carbonate are scraped up and the material gathered for industrial use.

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K-2414. Jan. 14, 1958. East of Kanpur. Solonetz-like film over shallow bare spot in halomorphic phase of Kanpur type No. 2.



K-2415. Jan. 14, 1958. Near Lucknow. Excellent gully control by guarding, and some tree planting after diversion

I

N2414

K-2414. Jan. 14, 1958. East of Kanpur. Solonchek-like
film over shallow bare spot in heliographic phase of
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II

N2415

K-2415. Jan. 14, 1958. Near Lucknow. Excellent fully
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After another 3 or 4 miles the soil gradually improves. It is especially bad for the surface soil to be removed here because of the croute calcaire in addition to salt and poor drainage. I notice that in places the kankar is dug out and used for road material.

We pass an irrigation canal in a small village with a good deal of digging nearby. Generally in this whole area drainage works are absent or wholly inadequate, especially where irrigation water is used. As we go on we pass a few good crops of pigeon peas in favored places, but only paddy can be grown in the low places and no winter crop.

We see so much current digging and so many low places that I suspect that ancient digging has been much greater than these people realize. Then too, the use of the surface soil from a wide strip for making the road grade has contributed greatly to the formation of wet, saline soils.

We pass Nawabganj and another large canal in an area of the halomorphic phase of Kanpur type No. 2. The soil is used for paddy and rough pasture.

We stop briefly to look at an area of about 15 acres that has been fenced for experimental controlled grazing. This has not been an economic success considering the cost of fencing. The land furnished about 27 rupees per acre annually for either fodder or pasture. The quality of the grass is much improved by controlled grazing. The rough pastures without control give essentially no return. Under the best situation of controlled grazing I am told

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that two or three cattle may be carried per acre per year.

The high elevation of an old Hindu temple along the road suggests to me a great deal of ancient digging and soil removal. Then of course, soil has been removed for the mud houses, and more recently for bricks. Now some soil areas are so wet and salty that they are not even grazed. Near the road I even see people bathing in the lower part of these wet salty places!

We pass on to higher better drained soil with mixed mustard and wheat and pigeon peas, with paddy plots in the lowest places.

We cross the Sai River and onto Kanpur type No. 3. Slight differences in relief and depth to water are responsible for great differences in the soils. (Here there are a great many monkeys). At the edge of the next village I see more evidence of digging. These mud houses are certainly short-lived and a lot of soil is required over the years. Near the village there are a few fields of castor beans.

Then we pass over a large open area of Kanpur type No. 4 (The halomorphic phase of type No. 3), with paddy in the wet season and rough grazing in the winter. Much of this land is nearly waste. We pass another irrigation canal in this flat with inadequate drainage. Even paddy yields are low I am told.

We pass a "land institute" where boys go for two years after high school to study agriculture. Since they get diplomas they are referred to as "diplomats."

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are referred to as "diplomats."

We pass the airfield and approach Lucknow, the capital of Uttar Pradesh. The soil is Kanpur type No. 4 with many old diggings. The streets are very dusty even though the central part is paved. The population is said to be 700,000. The rainfall is 37 inches and the elevation 400 feet.

This is a nice city with wide streets and many nice buildings and gardens. There are also some nice shops. I am told this was called the "garden city" of the Moguls. Now it is a center of the Mohammed religion and nearly half of the people are Mohammedans. There are many art and craft industries and Lucknow is said to be quite an art center.

We leave our bags at the Carlton Hotel. I go by truck to Dr. Kahn's office. There I meet also Mr. H. C. Seth, Deputy Director for Soil Conservation Extension. They show me maps of ravine erosion. This had been seen also near Agra. I am sure a great part of this is geological and not the direct result of cultivation, although farming has doubtless expanded them. Since no measurements have been made no one really knows.

I am shown so-called soil conservation surveys of villages that indicate surface soil texture, soil slope, erosion, and land-use. The scale is 16 inches equal one mile. It is quite difficult to find out what criteria are used for mapping erosion. I suspect it is largely guess work. For village reconsolidation some maps were made at 1 inch equals 165 feet. I am told that if cultivators have their plots on very poor soil there is no way to move them.

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These village plans call for some drainage structures and spillways as well as dams. Twenty-five percent of the cost of the conservation works are commonly given as a subsidy and 75 percent of the cost is borne by the cultivator. In accordance with a rough classification, the "B" class of cultivators get a subsidy of 25 rupees with a cost of 100 rupees per acre; the "C" class cultivators get about 100 rupees per acre subsidy; and the "D" and "E" classes of cultivators 150 to 200 rupees per acre. On these last ones the government pays all the cost as a subsidy. (These classes are based on the work to be done.)

Dr. Kahn is very glib in explaining how fast these ravines form from accelerated erosion. But he has no data or measurements at all and I doubt that his judgment is reliable. Dr. Agarwal points out clearly that the so-called soil conservation surveys are of no value in recommending fertilizer use because the lower soil has not been examined. Dr. Kahn insists that he has a "general" idea of the fertilizer needs. He says that on the experimental farm yields have gone up about 9-fold with soil conservation.

I am told that locally this saline-alkali soil is called usar land. Dr. Kahn shows me pictures where bunding and leaching with extra water have improved these soils where they are reasonably permeable and where the water table is around 6 feet to 10 feet during the monsoon. The leaching is done April or June.

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Mr. Seth takes me back to the hotel and I have lunch with Dr. Agarwal as my guest. I discover that he is a vegetarian. He tells me that there is no solution whatever to the cattle problem in India!

I have a long talk with him about his previous assertion that the Center should not have soil mappers on its payroll. I point out to him that if the Center is making grants for irrigation and for soil conservation where soil surveys are needed and the States are unable to do the work why couldn't the State and Center have combined parties. He says, "I see no reason why they couldn't." He emphasized the great scarcity of qualified people for soil survey work, and says there are not over 40 in India able to lead soil survey parties. (Added later: 40 would be a very, very generous estimate).

I asked him about soil blowing in some of these sandy soils and he tells me that there is very little wind in this part of India.

At 2:00 p.m., we leave for the State soil conservation field station, north of Lucknow about 11 miles. In 1950 1,150 acres were acquired for it.

Here I again see the inevitable runoff and erosion plots with two-foot fills of different kinds of surface soil brought in from the outside! This is certainly a silly procedure. The earlier plots may have some value since they were placed on existing soil.

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The soil scientist here tells me that the soils of the station are mainly eroded phases of the Kanpur type No. 3. I see good control of gully heads by reforestation and grass with special emphasis on Dalbergia sissoo trees. The irrigated part has crops in small plots surrounded with low bunds. They tell me that broad-based terraces were tried but were not highly successful and are being converted to narrow-based ones, locally called bunds. There is no reason why broad-based terraces would not work if they were put in properly. I think the point is that the laborers know how to make the old style bunds and were not given proper instructions for making the others.

I see good plantings of papaya and excellent sugarcane for this region. The sugarcane here gets 120 pounds of nitrogen as sulphate of ammonia. The yield is about 20 tons as a 12-month crop with 11 percent sugar.

I urge that this farm, obviously highly responsive to fertilizer, be included in the soil testing scheme. I notice good examples of phosphorus deficiency on the summer legumes.

Dr. Agarwal tells me that in this community available fertilizers are used first on industrial crops, then on food crops, and last of all on forage.

I am told there is a staff of 100 here with 30 trained people. They have a budget of around 200,000 rupees not including any non-recurring items. They sell products valued at 80,000 rupees. The station looks good but it seems to me that the staff is far larger than needed for the amount of work being done.

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State Conservation, Demonstration, Research, and Training Center Farm at Rehman Khera, near Lucknow. January 14, 1958. (S.P.R.)

On the way back to the hotel we stop at a famous mosque built about 1700, partly as a make-work project during a financial depression. Even middle-class people worked on it, but at night when they could not be recognized. Dr. Kahn tells me that his wife has memorized all the Koran. I also see a new monument to the Indians that were killed during the unsuccessful revolution against the British in 1857.

After returning to the hotel I clean up for the evening. The transformer for my razor becomes very hot. It is an old one I bought in London many years ago so I suppose it is finished.

Dr. Sen takes Raychaudhuri and me down shopping. I look for a new transformer. We walk all over the city. Shops are open until 9:00 p.m. Although this is the cleanest city I have yet seen, disorder is common. Many are asleep just rolled up in dirty blankets on the sidewalk. There are many poorly stocked little shops of every description, and a few nice ones, some large.

I buy an Indian-made transformer considerably heavier than what I should like. We go back to the hotel and I find that the new one also gets hot. Then I realize what my trouble has been all along. The electric current in my room is D.C. not A.C. So I wasted my money and got a heavy transformer that I don't need. This is about the most foolish thing I ever did while traveling.

January 15: Despite mosquitos and noise I slept fairly well last night. I am through breakfast at 8:00. This promises to be another warm, sunny day, about like late May in Washington. Dr. Sen comes

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Dr. Raychaudhuri and we are to check in for the airplane trip to Patna here in the hotel. I give Dr. Sen the transformer and my receipt for it. He says he will return it to the store and send me the money. But I don't really expect to see it.

We then leave in a crowded, funny little bus at 8:45 a.m. The windows in this bus are so low that one can hardly see out. The streets are terribly crowded with people, push carts, rickshas, bicycles, cows, pony taxis, trucks, buses, and bullock carts beyond count. The people wear just about every conceivable type of clothes. Here, as elsewhere, women along the road dash out in the traffic with baskets to scrape up any horse or cattle dung for their fuel supply. Yet this city is much cleaner than Kanpur or old Delhi.

At the airport I see workmen digging the soil - a pale brown sandy clay loam - with heavy hoes to about 9 inches. The work is very hard and the men are not strong. Ahead of the hoers, men dig up every bit of the Bermuda-like grass that will be sold for fodder or fuel. I see a few lime nodules in the surface soil, so I suppose this is a halomorphic phase of Kanpur type No. 2. I am told that the foreman is called a "kamdara," a semi-literate laborer. A sweeper is called "jamadar" and is not literate. I see gardeners cleaning grass from around small bushes, very slowly and inefficiently. And the shrubs have chlorosis, probably from iron deficiency.

After some delay we leave at 10:55 a.m. for Patna by way of Allahabad and Varanasi.

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I see this same alkali-saline soil for quite a distance. A few good patches are now in winter crop, the less good soil is used only for paddy, and there is some swamp and wasteland, especially barren digging sites. As we fly on east the rainfall increases and I am presuming that the salinity decreases. I should say that somewhere between 5 and 8 percent of the good soils has been ruined by these old diggings not counting the wasteland around the villages and along the roads. We pass over a small winding river with shallow gullies in places and some nearly barren land. Some of these barren areas are probably highly overgrazed common land. As we continue east there are more orchards. About 80 miles beyond Lucknow I should say that most of the soil not used for winter crops is used in the summer for paddy.

We cross the Yamuna River. There are a few shallow gullies but not many. In places there are side strips of riverwash in the bed. Near Agra such land is used for melons, but here it does not seem to be used. Across the river there are many small orchards, many villages, and less wasteland. I should say that about 60 percent of the land is used for crops.

We are down for a few minutes at Allahabad. There is said to be an old agricultural school here operated by American missionaries on reclaimed land. Here the Yamuna River joins the Ganga.

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As we fly on east I see considerable wasteland. Part of this is made up of old river channels that are probably salty; part is overgrazed common pasture; and a part is the result of diggings for brick material. Some of these river channels probably contain water in flood time. Most of them appear to be bunded for paddy. I should say that not over 60 percent of the farmland has a winter crop.

Of course these digging sites in the well drained soil could be reclaimed but it would be very difficult to do anything with the wet ones.

After much circling we land at Varausi (which appears as Banaras on all but the newest maps).

As we go on east toward Patna I see some erosion along the margins of the shallow streams. Here the Ganga appears to have a narrow flood plain. In places there are dikes and there doesn't seem to be so much saline and other wasteland here. About two-thirds of the way to Patna only about 5 to 15 percent of the cropland has no winter crop.

We are down to Patna at 1:41 p.m., and I am met by a large delegation including especially, Dr. D. Sen, a Cornell Ph.D., now in charge of soil conservation for the Damodar Valley Corporation. I also met Dr. P. Sinha, the agricultural chemist for this area and several of his assistants.

After the usual delays we drive along a wide street with many nice old and new buildings. It is quite hot here. Unhappily,

As we fly on east I see considerable wasteland. Part of this is made up of old river channels that are probably salty; part is overgrazed common pasture; and a part is the result of diggings for brick material. Some of these river channels probably contain water in flood time. Most of them appear to be bounded for paddy. I should say that not over 60 percent of the farmland has a winter crop.

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After much circling we land at Varanasi (which appears as Banaras on all but the newest maps).

As we go on east toward Patna I see some erosion along the margins of the shallow streams. Here the Ganga appears to have a narrow flood plain. In places there are dikes and there doesn't seem to be so much saline and other wasteland here. About two-thirds of the way to Patna only about 5 to 15 percent of the cropland has no winter crop.

We are down to Patna at 1:41 p.m., and I am met by a large delegation including especially, Dr. D. Sen, a Cornell Ph.D., now in charge of soil conservation for the Damodar Valley Corporation. I also met Dr. P. Sinha, the agricultural chemist for this area and several of his assistants.

After the usual delays we drive along a wide street with many nice old and new buildings. It is quite hot here. Unhappily,

Dr. Raychaudhuri insists that we go to the headquarters here of the Department of Agriculture of the State of Bahir. This means we shall be very late.

Field experiments were started here in cultivators' plots because the results from the experiment station could not always be applied. (This seems to be in accord with the recommendations of Dr. A. B. Stewart). Besides the control, they have one plot with a low level of fertilizer and one at a high level. Later they expanded these to include besides the control, two levels of nitrogen, two levels of phosphorus, and one level of potash. Now they have besides the control, three levels of nitrogen, three levels of phosphorus, and three levels of potash. In a village this means 27 plots with treatment and three control plots. Each plot is 1/20 of an acre. One-third of the plots (10 plots) are located in each one-third part of the village. They try to get these on soils that are relatively uniform in surface texture. The plots are for one year and are selected at random. The soils developed from alluvium here seem to respond to potassium and often the nitrogen-potassium treatments are as good as the nitrogen-phosphorus treatments. They get responses from light loams from alluvium, the clay loams from alluvium, and the red soils from biotite gneiss.

As a result of this work it is said that fertilizer use has increased from 1,000 tons to 35,000, with particular emphasis on phosphorus. Experimental work has been done with paddy, wheat,

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With the staff at the Laboratory for Field Experimental Service,
Kadam Kuan, Patna, January 15, 1958. (S.P.R.)

maize, potatoes, chickpeas, peas, pigeon peas, and sweet potatoes. About one-half of the experiments are on paddy.

These experiments were laid out without much regard to soil. Now they expect to make soil surveys. I doubt that these will be much help because they are making them at 1-inch to the mile using grids 2 miles apart. Profiles are described in the field and chemical analyses are made of each profile. It is said that boundaries are drawn in this field but this is not clear to me. The workers do field work for about 5 months and the laboratory work for about 6 months. They insist that it is too wet to work in the field from May through October. They had done earlier work on 6-mile grids.

I am told that all the cultivators in a village use the same practices based on recommendations of soil tests. Obviously, these recommendations are not as precise as they should be.

We finally leave at 3:00 p.m. for Hazaribagh. It is a great pity that we stopped at this station, which is hardly fair, because it means a lot of driving in the dark. Dr. Sen of the DVC already impresses me as much above the average.

We go east along the Ganga River, then south through Bihar. Here the lowland is protected by a large dike against flooding by the Ganga River. The dike is partly earth, but mostly brick. Here, too, there is much low wasteland along the road caused by making the

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too, there is much low wasteland along the road caused by making the

high grade from very shallow borrow pits. After two or three miles the high road grade comes up the dikes. The ill-drained soil is used for growing wheat and vegetables. The lower places are wasteland thickly covered with sugar cane. This swampy area is said to be flooded every year. The drainage into the



K-2416. Jan. 15, 1958. East of Patna. Ill-drained, productive soil with counterpoise wells. (Note destructive shallow digging for road grade in foreground.)

pendent in her eyes). I see several patches of very tall sugar cane. The cultivators' houses here are made of mud and brick with earthen roofs. Besides the regular crops they also have sugar cane. Most of this good land here is irrigated.

Obviously, the cultivators here and their families are not fully occupied. I notice many small round flat cow dung cakes for fuel stacked on the walls of the houses to dry. Here I see village workers making boards out of short, both large and small, logs by two men using handaxes.

high grade from very shallow borrow pits. After two or three miles the high road grade serves as the dike. The ill-drained soil is used for general crops and vegetables. The lowest places are wasteland thickly covered with water hyacinths. This cropping area is said to be flooded every year. Yet despite this they sometimes get three crops of potatoes in one year. Palmyra palms dot this part of the landscape. These are tapped for a juice to make alcohol. I notice that the crops are very weedy. The wells here have a bucket on one end of a long pole and a counterweight on the other end of it. Even here we see a lot of soil ruined by digging for bricks. This is a great pity in such a productive soil. As the drainage improves I see many mango orchards. The traffic is very heavy. (I note one village woman with a great brass ring and pendant in her nose). I see several patches of very tall sorghum. The cultivators' houses here are mostly a combination of poor brick with earth added as plaster. I see peppers (chili) laid out on swept earth or paper to dry. Besides the regular crops they also have castor beans. Most of this good land here is irrigated.

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We pass Bakhtiarpur and turn south toward Bihar. We have a long wait here at a railway crossing. I try to photograph an old man who is spinning flax as he walks along. After 10 minutes a train passes; but since they expect another the gates remain closed. While we wait I meet a Mr. Sing, one of the board members of the DVC. He is worried about a strike at one of their dams. At last the gates are open but I see we shall have most of this trip in the dark.

We pass a large area of wet land used mostly for paddy. The road is narrow and there are many bullock carts. Progress is slow. On the slightly higher soil there are some winter crops, partly irrigated from wells. Some of these are Persian wells. There is some wasteland from brick digging but not so much as near Delhi. About 5:30 p.m. I see hills to the west. In a few moments it will be too dark to see the fields. We pass on to a well drained fairly sandy soil from alluvium and then through the village of Nawadh. As it becomes dark we cross a sand river, the Phalgu, with water under ground.

Then we have a long hard drive for some 70 miles, first through steep hills on a winding road and then on a nearly straight road. We reach the guest house of the DVC at Hazaribagh at 8:00 p.m. The others go elsewhere and I have dinner by myself except that Mr. Hull, formerly of the SCS, comes in and visits while I eat.

I clean up a bit, straighten out my baggage, and make ready for bed. It is certainly a pity that we had this long stop in Patna and thus the last 70 miles in the dark.

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Hull told me this evening at dinner that the soil maps here do not have boundaries, only drawings of the profile! This is something that I hope I can get fixed.

January 16: I am up at 6:10 and the bearer brings me tea. I step out into the garden before breakfast and the flowers near the buildings remind me of the Congo. The garden soil is a medium brown, sandy clay loam. Now in the dry season it is cracked in polygons about 1 to 2 feet apart and the cracks are 1/4 to 1/2 inch wide. Nearby I see boys making an excavation using the counterpoised poles like those used for the shallow wells.

After breakfast Dr. Raychaudhuri and Dr. Sen come. I am told by Dr. Raychaudhuri that some of the new villages developed to take care of the cultivators flooded out by the pools were not successful because some of the cultivators did not think the soils are so good as those they had before. Now the DVC gives compensation to many of the cultivators in cash rather than in land. Dr. Sen says that even those who get money do not want to go very far from their former villages. Only a few of those moved out of the pool areas have gone into industry.

We take a quick look in a museum and see some of the maps of the area and then go out to a soil survey "camp." On the way I notice that this town is expanding, probably as a result of the DVC.

The soil here is called "red soil." Apparently this general term covers a lot of soils that are not red. We soon pass by paddy fields with no winter crop during the dry season. Some of the deep graying of the surface soil, perhaps most of it, is due to long use

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Tentative programme of visit of
Dr. C.E. Kellogg to the Soil Con-
servation worksites.

16.1.1958:

Exhibition - 8.45 to 9.30 a.m.

Dep. Hazaribagh at 9.30 a.m.

Arr. Meru at 9.45 a.m.

See Soil Survey & Planning work.

Dep. Meru at 12.00

Arr. Hazaribagh at 12.15 p.m.

LUNCH & REST:

See Soils Laboratory - 2.45 to 3.15 p.m.

Dep. Hazaribagh at 3.15 p.m.

Arr. Lupung at 3.45 p.m.

See Soil Conservation Demonstration work.

Dep. Lupung at 4.30 p.m.

Arr. Hazaribagh at 5.00 p.m.

Tea , Discussion

TEA, DINNER AND HALT:

17.1.1958:

Dep. Hazaribagh at 8.30 a.m.

Arr. Deochanda at 9.00 a.m.

See Deochanda Experiment Station.

Dep. Deochanda at 9.40 a.m.

Arr. Singrawan at 10.10 a.m.

See Afforestation work.

Dep. Singrawan at 10.50 a.m.

Arr. Bachhai at 11.00 a.m.

See Bachhai Fish Farm.

Dep. Bachhai at 11.20 a.m.

Xxx. Hazaribagh at 11.30 xxx.

Arr. Sewai at 11.30 a.m.

See Experiment cum Demonstration Farm.

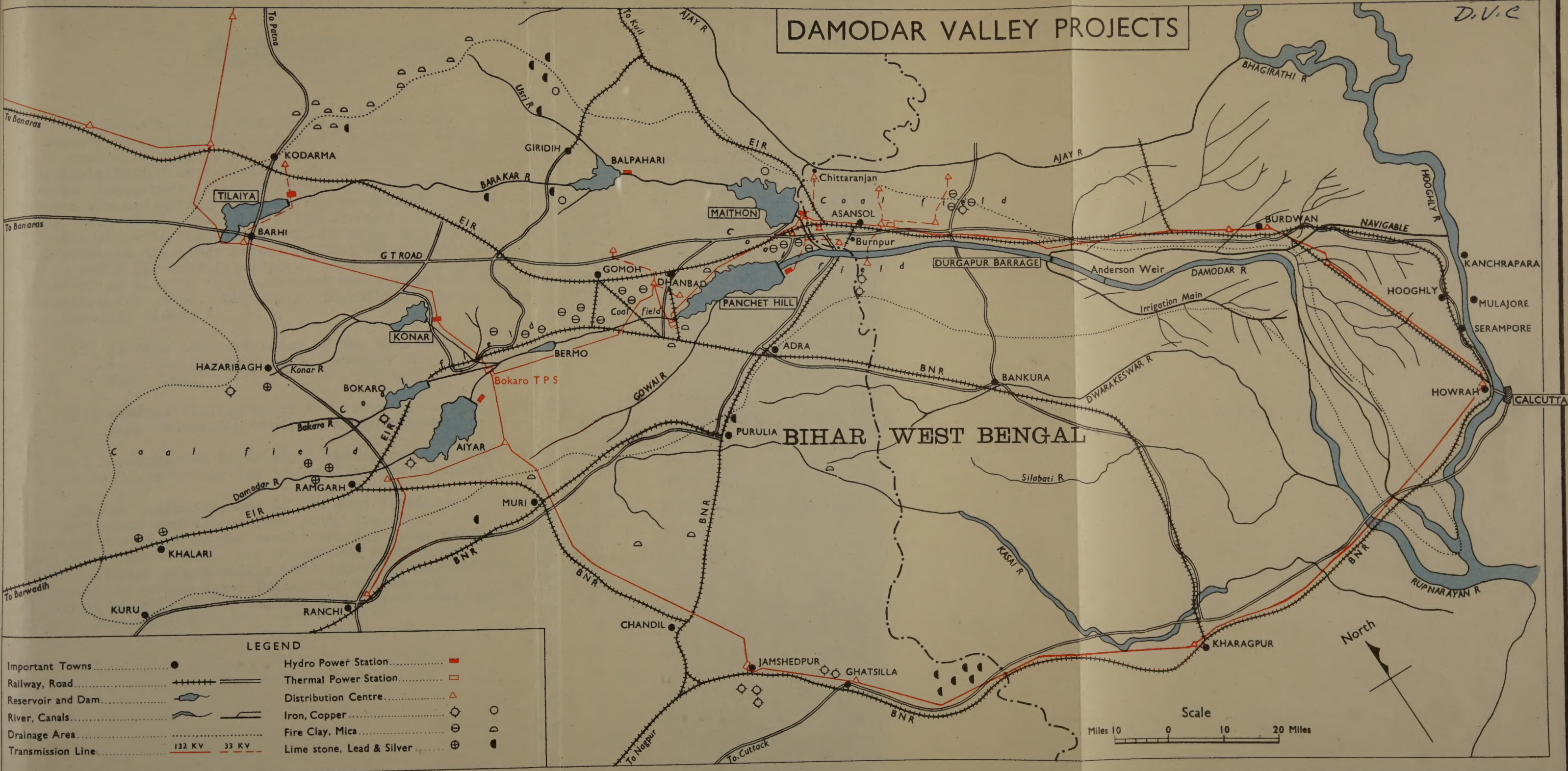
Dep. Sewai at 12.00

Arr. Hazaribagh at 1.00 p.m.

start at 8 am.

DAMODAR VALLEY PROJECTS

D.V.C

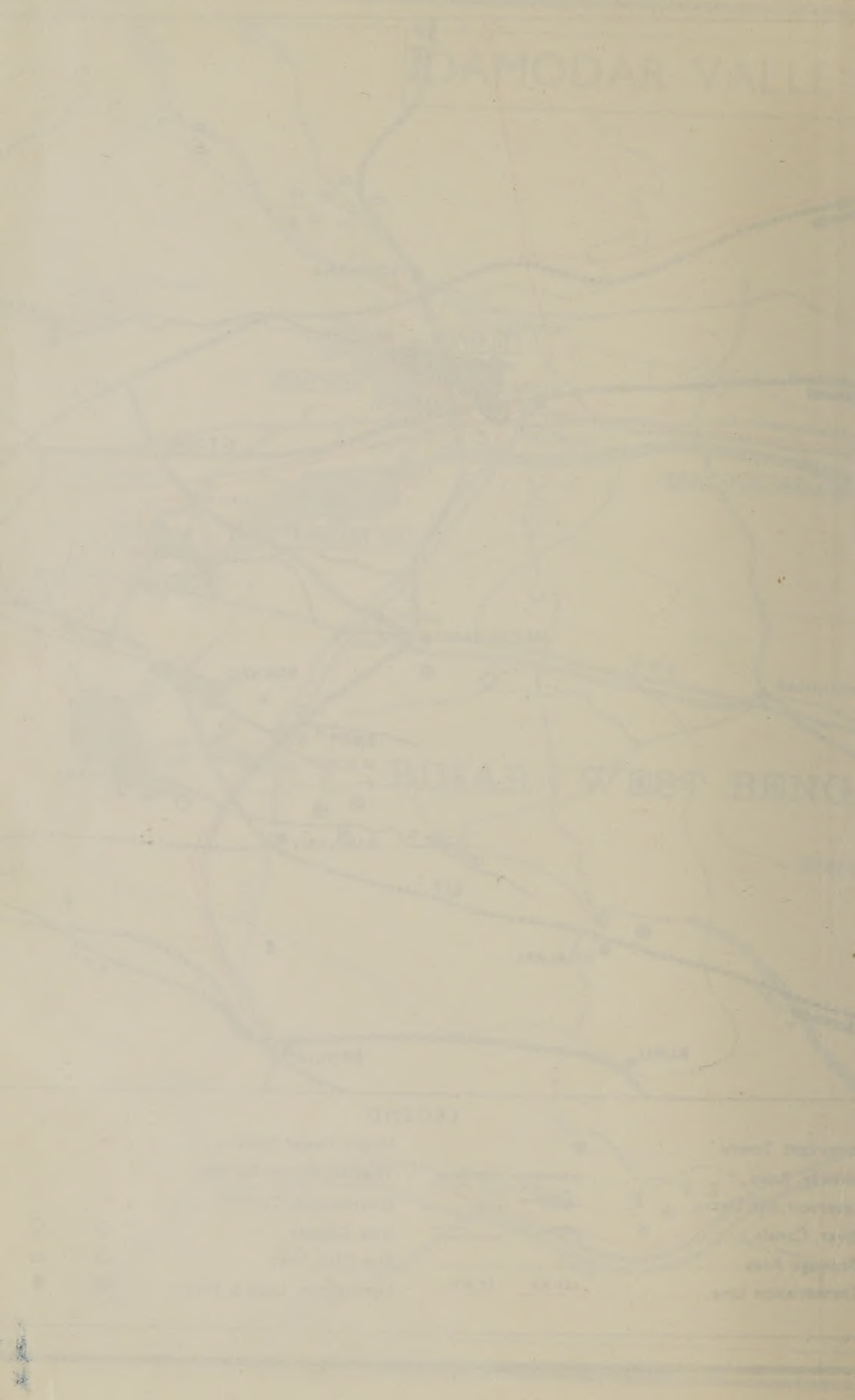


LEGEND

- | | |
|-----------------------------|---------------------------------|
| Important Towns.....● | Hydro Power Station.....■ |
| Railway, Road.....+ + + + + | Thermal Power Station.....□ |
| Reservoir and Dam.....■ | Distribution Centre.....△ |
| River, Canals.....— | Iron, Copper.....○ |
| Drainage Area.....D | Fire Clay, Mica.....⊖ |
| Transmission Line.....— | Lime stone, Lead & Silver.....⊕ |
| 132 KV.....— | |
| 33 KV.....— | |

Scale
Miles 10 0 10 20 Miles

DAMODAR VALLEY



DAMODAR WEST BEND

1. The Damodar Valley Corporation (DVC) is a public sector enterprise of the Government of India, established in 1948. It is responsible for the development and regulation of the Damodar River and its tributaries. The DVC has a wide range of projects, including dams, powerhouses, and irrigation schemes. The DVC also manages the Damodar Valley, which is a large, shaded region on the map. The DVC is a key player in the development of the Damodar Valley region.

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SOIL CONSERVATION DEPARTMENT
DAMODAR VALLEY CORPORATION

The Department was started in the year 1949 to deal with the problem of conserving the soil over the entire upper catchment which covers an area of about 7,200 sq.miles. In this area, ruthless exploitation of forests, over-grazing of grass lands and improper management of agricultural lands through many years have exposed the undulating land surface to the beating action of monsoon rain. Most of the rain that falls on such areas, therefore, rushes down the slope of the land as runoff water eroding away the surface soil which is the store house of plant nutrients, gradually rendering it unfit for sustaining plant life. This eroded soil is finally deposited as silt in the reservoirs and stream beds reducing their capacities for water. Obviously, therefore, erosion of soil acts as a two-fold menace -

- (i) gradual impoverishment of the soil thereby reducing the productive capacity of the land and
- (ii) gradual filling up of the reservoir beds by silt and thus decreasing their lives considerably.

The Soil Conservation Department, therefore, is aiming at combating the two evils by conserving the soil of the catchment.

In the beginning, one of the main functions of the Department was to reclaim wastelands into paddy fields for resettlement of the families displaced by the reservoirs and 6,541 acres of land have been reclaimed so far. The second and equally important was the investigations on scientific soil conservation measures and their introduction in the Upper Valley for reducing flood peaks and silt transport as well as for improving the productive capacity of the land. With the end of the land reclamation programme, the latter, i.e., the soil conservation work has become the chief function of the Department in the Upper Valley.

Since 1955-56, the Department has also taken up scientific work on the agricultural problems of the Lower Valley. With the completion of the Durgapur Barrage and the construction of canal system, an area of about one million acres in the districts of Burdwan, Howrah, Hooghly and Bankura will receive assured irrigation supply. This envisages a big change in the agricultural pattern of that area. Two or more crops can grow in a year where only one grew before. The introduction of new crops, new rotations and above all, the judicious utilisation of irrigation water are some of the main problems being studied for the Lower Valley.

The technical work of the Department is carried through the following Units :-

- 1) Research at the Soil Conservation Experiment Station, Deochanda.
- 2) Soil Survey and Planning.
- 3) Soil Conservation Extension on cultivators' fields.
- 4) Soils Laboratory.
- 5) Utilisation of emerging peripheral lands of reservoirs.

(Contd....2)

- 6) Soil Conservation Engineering.
- 7) Forestry.
- 8) Fisheries.
- 9) Special projects subsidised by the Central Soil Conservation Board.
- 10) Agricultural Experiment Station, Lower Valley, Panagarh.
- 11) Training.

Air Mapping:- The whole Upper Valley has been air photographed and about 4,650 sq.miles have been ground surveyed and maps prepared.

Soil Conservation Experiment Station at Deochanda:- Controlled experiments to measure the soil loss under different slopes and agricultural practices are in progress at this station. At present there are over 80 runoff plots where accurate measurements are being done. Besides, manurial and cultural requirements of important upland crops viz., Gora paddy, Marwa, Gondli, Peanuts and others are also being studied. The experiments on strip-cropping for conserving soil and restoring productivity of soil, on different types of terraces and on the water disposal systems have been started. A demonstration unit has been established where half of the area is cultivated according to improved methods while the other half is done according to cultivators' practice as a control.

A large number of grasses and legumes are under study to ascertain their suitability for different purposes viz., fodder, grazing, gully control, stabilising waterways & embankments, etc.. About 40 different grasses and 20 legumes are under such observations.

Soil Survey and Planning:- Soil Survey provides basis for land use planning. Soil conservation surveys for land development, grouping soils together on the basis of their capabilities, are being conducted in the valley. Such soil conservation survey maps give an accurate inventory of the physical characteristics of lands, like geomorphology, slope, erosion, soil depth, soil texture, present land use, location and extent of gullies, etc... These maps form the basis for effective planning and various soil conservation measures catchmentwise. A land capability table has been developed for use in the preparation of a conservation plan for a catchment to meet the problems that occur in the catchment.

Out of the area of 7,200 sq.miles of the Upper Valley, Soil Conservation Survey has been carried out in 465 sq.miles and land use maps drawn. The target for the Second Five Year is 2812.5 sq.miles, the annual target being 400 sq.miles.

Soil Conservation Extension:- This includes carrying the results of research to the cultivators' fields. The main programme consists of demonstration of conservation farming techniques such as terracing, contour cultivation, consolidation of individual holdings on contour, stablization of water disposal arrangements by biological and engineering measures, planning of farm roads, stabilization of gully heads, banks and beds, the latter for eventual reclamation as paddy fields. There are at present 20 such demonstrations covering about 1,047 acres besides 44 old demonstrations covering 1,839 acs. including gullies scattered in the various catchments of the Upper Valley. Investigation and planning for further demonstration is being undertaken in 24 more centres covering about 1,200 acres.

In order to accelerate the progress of this work a scheme is afoot to work through the N.E.S. blocks of the State Government.

Soils Laboratory:- A large number of samples from the experiment station, extension section as well as soil survey are being analysed. In addition, research work is being done to characterise the important soils of the Upper Valley for their physical and chemical properties. Pot culture work also is in progress to study the effect of trace elements on the important upland crops - Gora paddy and Maize.

Reservoir Emerging Lands:- The four large reservoirs are expected to emerge about 30,000 acres of periphery lands annually due to the draw down programme. Water is the limiting factor for crop production in the Upper Valley. Therefore, the creation of these reservoirs will help in increased production from the periphery areas, which are of high agricultural potential. Experimental farm at Sewai and the three demonstration farms at Urwan, Bundu and Konar have been started in order to work out the cropping patterns for these areas.

Fishery:- After the construction phase is over, the total fish production out of the available cultivable water area in D.V.C. on a very conservative estimate is expected to be in the neighbourhood of 50,000 maunds of fish annually.

Experiments and investigations were conducted in different aspects of pisciculture and some useful results have been achieved. The major carps (the economic species) have not so far been found to breed in the Tilaiya reservoir and, therefore, it has been decided that artificial stocking should be taken up. So far, Tilaiya reservoir has been experimentally stocked with about 20 lacs of fish seedlings and they have been found to be growing very satisfactorily. Experimental exploitation with gill nets has been found to be quite promising. The local fishermen have also been trained in this new method of catching by gill nets. Some experiments on fishery biology which are intimately connected with commercial fish production have been conducted. A fish farm at Bachhai has been established mainly for raising fish seedlings for stocking the Tilaiya reservoir and also for conducting some important experiments.

Upper Sewani Soil Conservation Project:- This scheme, subsidised by the Central Soil Conservation Board, extending over an area of 35 sq.miles in the upper catchment of Sewani river is in progress. The scheme involves introduction of soil conservation practices on an intensive scale on the farmers lands, government wastelands, other wastelands and forests with the active co-operation of the farmers in order to demonstrate what soil conservation can mean to their erstwhile neglected uplands when erosion is controlled and fertility built up. About 1,025 acres of uplands and gullies have so far been treated with measures like terracing, strip cropping, grassed waterways, establishment of proper water disposal system by construction of drops, chutes, outlets, flumes, etc. conservation ponds, pasture, meadow, fencing for protection against grazing, gully control and consolidation of uplands on contour.

The forestry part of the programme provides for improvement and regeneration of critically situated depleted and highly eroded forest areas in the catchment. Three square miles of such forest land is to be taken up under the scheme for improvement and regeneration.

In 1955-56 a block of Bihar Protected Forest comprising 440 acres situated just above the Charwa reservoir was taken up under this programme. The area was fenced, fire protection measures undertaken, and check-dams, diversion channels, etc. constructed in and around the gullies. The crooked and mal-formed stems were coppiced back to ground level for encouraging healthier shoots. The existing blanks in between scattered vegetation was planted up with rapid growing timber and fire-wood species. After about 18 months of closure, the area has already re-cooperated to a great extent. Considerable amount of leaf litter has already accumulated in the forest floor. Natural grasses have come up profusely decreasing the sheet erosion to a considerable extent. The local villagers are removing these grasses for fodder and thatching purposes free of any charge.

Another two blocks of similar depleted and eroded forest land have been taken up for improvement and regeneration work in 1957 April at Pabra and Rautra villages comprising 438 acres. Fencing and anti-erosion measures are already complete in these two blocks also where planting and sowing will be done in 1957 monsoon. Similar programme will be continued on more blocks in subsequent years.

Soil Conservation Engineering:- The work of this Section is closely related to the extension work where engineering structures like chutes, check dams, spillways, ponds etc. are to be put up in order to control gullies and arrange for the safe disposal of water so that the movement of silt is reduced to the minimum. A large number of these structures have been put up.

In order to demonstrate to the villagers various methods of erosion control and conservation of soil and water in uplands and gullied areas, a pilot scheme in 250 acres was executed at Gonda and is being maintained. Cropping in collaboration with extension staff has been organised on sound lines in upland and holdings of individual farmer have been consolidated on contour in about 65 acres. Farmers have reclaimed some of the treated gullies and have taken up cultivation where silt has deposited. Sills of some of the structures have been raised for further siltation and reclamation of the gullies by the farmers is in progress. It is expected that farmers in the neighbouring villages will adopt similar measures in their lands. It is proposed to take up more demonstration schemes of similar nature.

Small eroded areas in Upper Damodar and Upper Barakar have been selected and 350 acres of area have been treated with simple engineering measures like check dams, spillways, chutes, ponds, etc. with a view to stop erosion in these areas and demonstration of simple engineering techniques to villagers, as well as general development of the area. Field studies have been organized at the Deochanda Experiment Station with the idea of evolving cheaper structures for erosion control and also to arrive at accurate design of terraces and other soil conservation measures. Devices for observing the runoff and soil loss from the field under different soil conservation practices have been installed and observations will be conducted during the monsoon.

A small scheme of hydrological studies in small catchments has been recently taken up. Study of water and silt discharge have been done in 1956-57 in Garga and Isri sub-catchments. The studies are continued this year added with rainfall studies for the area and it is proposed to extend the studies to a few other sub-catchments as well. These studies are essential for the correct design and evaluation of effect of soil conservation measures.

Forestry:- The importance of forests in reducing soil erosion for augmenting the life of costly reservoirs and proper utilization of land, steep and subject to erosion, have been recognized by the Corporation from the beginning. Most of the lands suitable for afforestation in the Upper Catchment are under the control of the Bihar Forest Department. But in order to ensure that the urgency of the problem is not over-looked, the Corporation maintain a separate Forestry Section in the Soil Conservation Deptt. This Section first started afforesting areas near rehabilitation villages where the people displaced by reservoir submergence have been resettled, in order to supply firewood, small dimensional timber and fodder. So far more than 700 acres have been successfully afforested near rehabilitation villages primarily to meet their requirements. Fodder grass, materials obtained from thinning, etc. are given free from these areas to the rehabilitation villagers.

Areas for afforestation are selected generally on the basis of land capability and are fenced with barbed wire. Gullies are treated by diverting water and putting check-dams. Greater parts of the areas are transplanted with seedlings 2' ft. or more in height in specially prepared pits to establish plantations quickly. Sowing is done only on selected locations using species that do well by direct sowing. Contour trenching is done in areas where erosion cannot be controlled quickly by vegetative methods alone. Species that are quick growing and are useful to the local population, such as, Sishum, Bokain, Neem, Gamhar, Siris, etc. are planted in the areas. Exotic species like Eucalyptus, Cassia siamea, etc. have very rapid growth and they are also being tried in these areas.

Forest lands that are under the control of the Bihar Forest Department but is in an extremely depleted condition, and is contributing great silt load into the reservoirs are also looked after by the Forestry Section, in critical areas under agreement with the Bihar Government, e.g. a block of Bihar Protected Forests, situated near Charwa Reservoir, which supplies water to the Hazaribagh town has been taken up by the D.V.C. for improvement and regeneration.

Up to the end of March, 1957, a total area of 2,711 acres have been taken up for afforestation by the Forestry Section of the D.V.C. as shown in the table below. This includes 740 acres that will be planted in 1957 monsoon. Plantations have successfully been raised already in rest of the areas.

PROGRESS OF AFFORESTATION UNDER D.V.C.

Year	Established plantations (acres)	Plantations completed during the year (acres)	New area taken up during the year (acres)
1952-53	--	--	150
1953-54	--	150	284
1954-55	150	284	512
1955-56	434	512	1,025
1956-57	946	1,025	740
Total upto end of March 1957			2,711 acres

During the Second Five-Year Plan provision has been made for afforestation of 2,500 acres in the Upper Valley. Out of this, 5,000 acres will be done by Forestry Section of the D.V.C. and the rest by the Bihar Forest Department on behalf of D.V.C. The Forestry Section of the DVC will take up very badly eroded areas ~~xxxxx~~ needing concentrated attention.

Panagarh:- The D.V.C. with its Barrage and Canal System has started giving irrigation water to some parts of Lower Valley. When fully completed the canal system will provide kharif irrigation to 1.04 million acres and rabi irrigation to 300,000 acres in the commanded area in Lower Valley. An experiment-cum-demonstration farm of 210 acres has been started at Panagarh in the commanded area with the primary objects of finding out solutions to the various agronomical problems connected with irrigation farming. A scheme on water requirement of crops commonly grown in this region has been sanctioned by the I.C.A.R. to be carried out at this farm with a view to recommend to the farmers of the commanded area, the proper dose, frequency and time of irrigation. Studies on crop rotations, intensity of cropping, cultural & manurial studies for important crops for improving the overall field of agriculture are being conducted. To obtain the optimum benefits from irrigation, it is necessary to be aware of the soil characteristics. Hence studies will be conducted in the physico-chemical changes in soil, behaviour of water tables and drainage problems as a result of introduction of perennial irrigation in the area. In collaboration with the Agricultural Department of West Bengal, it is proposed to carry out an educative programme amongst the cultivators on the proper utilisation of irrigation water and better land management to maintain productivity on a long term basis.

Training :- The training course under the Soil Conservation Training Scheme of Central Government is in progress and at present 16 candidates are undergoing this training. The course is of six months duration and consists of theoretical and practical work on all aspects of soil conservation. Four batches have so far completed their training.

T. J. Mirchandani
DIRECTOR OF SOIL CONSERVATION
DVC., Hazaribagh.

SOIL OF UPPER DAMODAR VALLEY

The Upper Damodar catchment containing an area of nearly 4.5 million acres (6960 sq. miles) in the hilly terrain of Chotanagpur contains two types of soil, namely :

- 1) Red loams with yellowish red soils, being the predominant soil type of the region,
- and 2) Calcareous soils, having dark grey coloured top soils occurring as irregular patches throughout the region.

The soils of this region have been developed under an average annual precipitation of 50-55 inches and temperature varying between 39°F and 107°F from the Archaean group of granites, gneisses and schists. The characteristic topographical and climatic conditions, nature of vegetation and parent materials as well as the forces of denudation have played a very complex and important role in the pedogenic processes leading to the development of the characteristic soils of the region. The alternate wet and dry periods coupled with high temperature prevailing in this region bring about rapid weathering of parent materials, increased microbiological activity and decomposition of organic matter as well as intense leaching resulting in the preferential removal of soluble constituents like calcium as well as colloidal silicic acid and accumulation of iron and aluminium oxides. The soils developed under these edaphic and climatic environments have the characteristic reddish tinge (due to iron oxide) with a tendency of laterization. On the other hand, the upper layers of the solum of this undulating region are subjected to erosive action of the ~~monsoon~~ torrential rains. This is further aggravated by the denudation of the protective vegetative covers due to indiscriminate destruction of the forests and other misuse of lands. These conditions are detrimental to the progress of maturity of the soils. The predominant soil type of this region may tentatively be classed as "Red loams", an intermediate stage in the process of laterization.

The "Red loams" with characteristic reddish tinge are derived from acidic rocks like biotite gneiss. They are highly leached and neutral to acidic in reaction. Free carbonates are either absent or their contents very low. They are usually deficient in organic matter, nitrogen and available phosphoric acid while the potash contents are usually high. Due to high proportion of free sesqui-oxides, these soils have a tendency of fixing added phosphatic fertilizers. The cation exchange capacity is also of very low order. The soils are usually shallow with light permeable ~~to~~ top soils ^l ^{by} ~~underlain~~ ^{lay} mottled concretions of quartz and iron oxides.

The other soil type, calcareous in nature, are developed from basic rocks like hornblende schists which give rise to calcium carbonate on weathering. They have neutral to alkaline reaction containing varying proportions of lime concretions throughout the profile. The soils are usually deeper and heavier in texture than the red soils. They have low permeability due to poor structure, high clay contents and frequent presence of clay pans in the subsoil. These high lime soils have a tendency of reversion of phosphatic fertilizers.

General characteristics of different horizons :

On the basis of analysis of over 3,000 soil samples from different parts of the upper catchment it has been found that there is, in general, an increase in pH, carbonate, silt and clay contents and decrease in organic matter and nitrogen contents with increasing depth of the soil.

Fusion analysis of the soils show that they are rich in sesquioxides and ~~p~~otash contents. This is true ~~on~~ the case of both top soils and also of the subsoil below.

Properties of top soils :

The top soils of the uplands are usually of lighter texture (e.g. loams, sandy loams, loamy sand etc.). Soils of heavier texture are usually met with in the case of paddy fields and depressions as well as in the case of calcareous soils. It has been found that 77 % of the top soils of the upper catchment have light texture. Moisture holding capacity and moisture contents at sticky point for a number of samples show that the values increase with increase in clay contents of soil and also with increasing depth of the soil due no doubt to the simultaneous increases in silt and clay contents.

The nitrogen and organic matter contents are also very low and their deficiency is wide spread. About 65.5 % of the soils contain less than 0.05 % nitrogen, 23.5 % contain between 0.05 and 0.075 % N. whereas only about 11 % of them have more than 0.075 % N.

The available phosphoric acid contents are very low throughout the region, about 95 % of them contain less than even 10 p.p.m. of available P (N/2 acetic acid soluble).

The soils are well supplied with potash, nearly 81 % the soils contain more than 0.015 % of available K_2O while about 18 % of them contain between 0.006 and 0.015 %. Soils containing less than 0.006 % available K_2O are rarely found and they constitute less than 1 % of the soils of the Upper Damodar catchment.

Fusion analysis of clay :

Studies on the clay fraction of the soils have been very few. The $SiO_2/Fe_2O_3+Al_2O_3$ ratio (molar) varies between 2.2 to 2.9 percent.

Cation exchange capacity of soils :

The results of studies on a few samples show that cation exchange capacity of the soils is very low and varies between 0 and 28.1 m.e. per 100 gm. of soil. In the case of ^asoil from Deochanda the values show a tendency of increase with depth.

Phosphate fixation studies :

Properties of top soils

The top soils of the islands are usually of a texture (e.g. loams, sandy loams, loamy sand etc.). heavier texture are usually met with in the case of fields and depressions as well as in the case of calcareous soils. It has been found that 75 % of the top soils upper catchment have light texture. Moisture contents and moisture contents at wilting point for a number of soils show that the values increase with increase in clay content and also with increasing depth of the soil due to the simultaneous increases in silt and clay content. The nitrogen and organic matter contents are low and their deficiency is wide spread. About 65 % of the soils contain less than 0.05 % nitrogen, 23.5 % contain 0.05 and 0.075 % N, whereas only about 11 % of the soils contain 0.075 % N. The available phosphoric acid contents are very low throughout the region, about 95 % of them contain less than 10 p.p.m. of available P (N/2 acetic acid soluble). The soils are well supplied with potash, nearly all the soils contain more than 0.015 % of available K₂O, about 18 % of them contain between 0.008 and 0.015 % available K₂O, and 0.008 % available K₂O are very low and they constitute less than 5 % of the soils of the islands.

Phosphate fixation studies :

Phosphate fixation studies with a few red soils of the region have been carried out and the fixation appears to be of a very high order. As much as 785 lbs. of P_2O_5 per acre was immobilized in a period of 4 weeks in the case of a soil from Bishangarh, when the soil was incubated with 800 lbs. P_2O_5 per acre. Similar fixation was also noticed in the case of soils from Hazaribagh and other places.

Response to manuring :

A number of experiments have revealed that ^{defi}iciencies of nitrogen and phosphoric acid are widespread in these soils. The red soils respond ^{to} ~~of~~ applications of N & P_2O_5 in adequate doses for growth of different crops. Legumes have responded to applications as high as 400 lbs. P_2O_5 per acre. Cowpea showed response to application of molybdenum ~~g~~alts.

Gora paddy did not respond to N alone in the case of kenthol (Calcareous) soil presumably due to non-availability of the soil phosphates.

Sd/-

Sd/- (H. D. Bhaumik)
AGRICULTURAL CHEMIST

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This is a beautiful dry, warm sunny day.

We come to the soil survey camp and I am shown new maps with factorial legends.

- (1) Soil depth - 5 classes
- (2) Surface soil texture - 5 classes
- (3) Drainage - 3 classes
- (4) Soil slope - 5 classes
- (5) Erosion - 6 classes
- (6) pH - 3 classes, less than 6, between 6 and 7.5, and more than 7.5
- (7) Extra phases for (a) Stony soil
 - (b) Open land free of bushes
 - (c) Gravelly soil
 - (d) Bushy areas
 - (e) Kankar
 - (f) Hummocky
 - (6) Rocky
- (8) Underlying rock material - 10 classes.

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They are now mapping these with long fractional symbols on aerial photographs at a scale of 6 inches equal one mile. I am told they had been using until recently the village maps at 16 inches equal one mile. Many of these distinctions cannot be made accurately; and a very large part are not significant.

I can see at once that the work goes very slowly because of the illogical legend and useless detail. The maps are quite inadequate. Many of the separations being made are not significant and yet the surveyors are practically ignoring the characteristics of the subsoil and of the substratum that are really important. This is very poor work, especially for assessing the erosion hazard.

I take a look at the reddish soil near the camp. The soil is well drained on a field that slopes about one and one-half percent. The field is now in fallow. I am told the soil is cropped for about 2 years with the dryland crops and then fallowed for about 2 or 3 years under heavily grazed "pasture."

- | | | |
|----------------|---------|--|
| A _p | 0 - 5" | Yellowish red (5YR 4/6) sandy loam. It is now very dry. The soil has irregular breaking and is fairly easily friable to medium granular. |
| AB | 5 - 7" | Transitional |
| B ₂ | 7 - 21" | Red (about 2.5YR 4/8) clay with much grit. Poor irregular blocky structure. The soil is brittle and fairly easily friable to hard, medium and fine granular. The peds are only slightly vesicular. Some of the quartz fragments are coated and some are not. (But this pit is far too shallow and further illustrates the serious error of ignoring the substratum. The work of this group is very poor indeed.) |
| B ₃ | 21+ | The soil in this layer is like the above but merges into quartizitic gravels of irregular shape. |

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A _p	0 - 2"	Yellowish red (2YR 4/6) sandy loam. It is now very dry. The soil has irregular breaking and is fairly easily friable to medium granular.
AB	2 - 7"	Transitional
B ₂	7 - 21"	Red (about 2.5YR 4/8) clay with much grit. Poor irregular blocky structure. The soil is brittle and fairly easily friable to hard medium and fine granular. The beds are only slightly vesicular. Some of the quartz fragments are coated and some are not. (But this pit is far too shallow and further illustrates the serious error of ignoring the substratum. The work of this group is very poor indeed.)

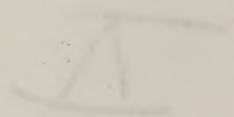
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K-2417. Jan. 16, 1958. Near Hazaribagh. View of slope at edge of newly eroding areas with stones for new stone line. (Red Latosol).

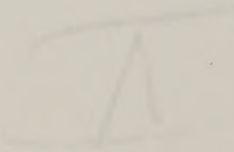


K-2418. Jan. 16, 1958. Near Hazaribagh. New surface resulting from gully erosion of old surface. These are smoothed and used for crops. (Red Latosol).



K2417

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K-2485. Near Hazaribagh. New erosion surface from Red Latosol. A new "stone line" is forming of quartz and lateritic concretions.

Discussing the genesis of tropical laterite, soils, and stone
lines at Hazaribagh, 5 miles east of Hazaribagh. January 16, 1950.
(S.P.B.)

48

K-2485

K-2485. Near Hazaribagh. New erosion surface from Red Latosol. A new "stone line" is forming of quartz and lateritic concretions.



Discussing the genesis of tropical landscapes, soils, and stone lines at Meru, 8 miles east of Hazaribagh. January 16, 1958. (S.P.R.)



Photos at Hazaribagh from H.D.N.Prasad

Locally this soil is called a "red loam." I think I should call it a Red Latosol.

In conversations I discover that none of these soil scientists ^{is} ~~are~~ familiar with the concepts of tropical soil profiles or of stone lines, which are so prominent among all such tropical soils. Both the material in the stone line and the concretions are loosely called "murrum."

In another pit to 38 inches the excavation stops within the B, which contains many small ferro-manganese concretions. In still another pit, below the A_p the reddish sandy loam goes to 18 inches with the reddish quartz gravel beneath it that represents the old surface.

Generally speaking, these soils are on smooth relief and are used for millet for 1 to 2 years and then are put in a kind of pasture-fallow from 1 to 3 years, which is severely grazed during this period.

The material in which this soil has been developed has gone through at least one erosion cycle and now a new one is starting. Gullies are working into it and the surfaces of some of these have become reasonably stabilized with the accumulation of both quartz and concretions. Thus I am able to explain the genesis of the stone lines with all of the story within 5 acres. The gullies here are not very deep since they run into a partially weathered biotite-granitic gneiss at a few feet. The bottom of these gullies are leveled off and diked for paddy.

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Back of the gully heads the usual cracks form at 1 to 3 feet; water undercuts the B horizon into the soft weathered rock; and blocks of the whole solum fall down into the gully.

I am told that the rainfall here is about 50 inches, mostly from June 1 to September 1. Some of the rains are quite intensive, around 3 inches per hour. They have recorded rains with an intensity of 9 inches per hour for around 5 minutes.

Unless some drastic measures are taken these gullies are going to continue to grow. The men simply must develop a completely different legend with well defined soil types. They have ignored the B horizon, which is the most important layer in considering the erosion hazard here.

After long usage of these soils for paddy I notice that they become gray and the structure nearly disappears. The soils are massive and crack irregularly when dry.

We have quite a discussion of mapping soil depth, which is essentially impossible because of the irregular stone line and the very irregular depth to the gneiss. I recommend that they set up soil types with ranges in depths and then confine any mapping of depth phases to situations where they know definitely that the differences are significant.

We go back to the rest house for lunch. Apparently I am getting full treatment but my Indian friends go elsewhere and leave me to lunch alone.

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I fear that the junior positions for soil scientists here have been filled simply with warm bodies and not with trained men. Some of the trainers of these men came to the United States sometime ago and now have a major problem to work out of the old erosion survey coded legend. Of course, coded legends always lead to trouble. They did not understand them when they were explained to them in the United States; and they have tried to apply them here even though they do not fit the situation at all.

After lunch I take a quick look at the laboratory where they have a soil testing laboratory including a flame photometer from the TCM. In this laboratory as well as in others I notice that the soils dispersed for mechanical analyses are setting in jars that are in a strong draft. No wonder I decided that the soils actually contain much more clay than their laboratory figures suggest.

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We then drive to a conservation demonstration on a cultivator's field. We go northwest of the city. At first I see mostly paddy without any winter crop on the land now. We pass on the margin of a very large area of fairly undulating paddy land. Probably this was once Red Latosol, but now it is strongly gleyed. Near the streams the red soil is eroding and some gullies are cutting back into the uplands. We pass over a large earth dam for flood protection, for the water supply for the city, and for irrigation.

We come into a fairly large area of smooth land with slopes of less than about $3\frac{1}{2}$ percent where I see fairly narrow graded terraces. The land in this village has been reallocated in relation to the terraces and the grassed waterway into which they lead. As in much of India, the village lands were divided into many, many small scattered tracts. Here a job of partial consolidation has been done by combining the holdings of each family into three holdings, one for each major kind of soil. At the edge of the tract that is terraced there is a large area of old gullied soil that is now protected from animals by a wire fence. The water from the grassed waterway is led down into the top of one of these gullies where there is an earth check dam and the usual protected outlet. These gullies have been gradually working into the upland. Apparently these soils had highly irregular horizons of calcium carbonate accumulations because of the many small low mounds of the concretions (kankar) mixed with the clay in the eroded, lower level.

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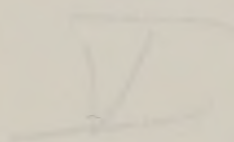
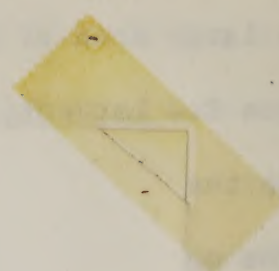
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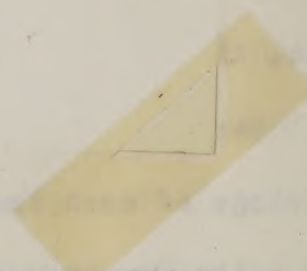


K-2419. Jan. 16, 1958. Near Hazaribagh. Paddy on sloping Red Latosol.

K-2421. Jan. 15, 1958. Near Hazaribagh. Paddy in eroded gully bottom.



R2419



K-2419, Jan. 10, 1956. Near Hecaribagh. Paddy on slope.
Red latosol.



K-2420. Jan. 16, 1958. Near Hazaribagh. View from below check dam into which grassed waterway leads. Guarded from animals.



K-2421. Jan. 16, 1958. Near Hazaribagh. Paddy in smoothed gully bottom.

II

K2420

K-2420. Jan. 16, 1958. Near Hazaribagh. View from below
check dam into which grassed waterway leads. Guarded from
animals.

II

K2421

K-2421. Jan. 16, 1958. Near Hazaribagh. Paddy in smoothed
gully bottom.



K-2486. Near Hazaribagh. Graded terraces for dry-land crops leading to a grassed waterway. In a village newly reorganized by partial consolidation of scattered holdings.

Four large dams will help reduce flood damage, and regulate water flow for irrigation, power and navigation. Three of these are already complete, and the fourth is well under way.

The reservoirs behind these dams are the essential elements for the success of the whole project. Without them there can be no flood control, no irrigation, no hydro-electric power, no sustained navigation.

The land from which water drains into DVC's reservoirs is badly eroded. Every monsoon takes a thin layer of soil from the surface of cultivated fields, over-crowded forests and depleted wastelands. Large gullies are running into good agricultural land, and even into forests, at a rapid rate. These processes not only destroy land and

most expensive of the project. This is a clear case of the year-long erosion. They trap silt and keep it out of the water reservoirs. Because they can have water, it is important to protect them as well as the big dams from sedimentation. The wheat policy is to keep the soil in place by using modern methods of soil conservation.

DVC established a soil conservation department in late 1948. The co-operation of the Technical Co-operation Office of the U.S.A. in this programme began in August, 1949.

DVC and the Bihar Forestry Department are at present co-operating in afforesting 5,000 acres of eroded land a year. It is hoped that this rate will be progressively increased. It is the responsibility of Bihar to establish proper management practices on the badly depleted soil lands that have been taken over from zamindars.

51

K-2486

K-2486. Near Hazaribagh. Graded terraces for dry-land crops leading to a
grassed waterway. In a village newly reorganized by partial consolidation
of scattered holdings.



A picture of neglect: a badly eroded land

SOIL CONSERVATION IN THE DAMODAR VALLEY

by

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DISASTROUS floods in past years led to the creation of the Damodar Valley Corporation in 1948. In addition to flood control, it has five other purposes: (1) promotion and operation of schemes for irrigation, water supply and drainage; (2) generation and utilization of electrical energy; (3) improvement of navigation; (4) afforestation and other soil erosion control; (5) promotion of general economic development in the valley.

Four large dams will help reduce flood damage, and regulate water flow for irrigation, power and navigation. Three of these are already complete, and the fourth is well under way.

The reservoirs behind these dams are the essential elements for the success of the whole project. Without them there can be no flood control, no irrigation, no hydro-electric power, no sustained navigation.

The land from which water drains into DVC's reservoirs is badly eroded. Every monsoon takes a thin sheet of soil from the surface of cultivated fields, overgrazed forests and depleted wastelands. Large gullies are cutting into good agricultural land, and even into forests, at a rapid rate. These processes not only destroy land and

forests, but send down large quantities of sediment to fill up the reservoirs and shorten their time of usefulness. It has been estimated that Panchet Hill, the largest and most expensive of the lakes, will last only 75 years. This is a short time in the life of a nation, especially when there are no more good dam sites available.

Headwater dams supply water for irrigation and for domestic use in towns. They produce fish, promote year-long stream flow and raise water levels in wells. They trap silt and keep it out of the major reservoirs. Because they too have value, it is important to protect them as well as the big lakes from sedimentation. The wisest policy is to keep the soil in place by using modern methods of soil conservation.

DVC established a soil conservation department in late 1949. The co-operation of the Technical Co-operation Mission of the U.S.A. in this programme began in August, 1953.

DVC and the Bihar Forestry Department are at present co-operating in afforesting 5,000 acres of eroded land a year. It is hoped that this rate will be progressively increased. It is the responsibility of Bihar to establish proper management practices on the badly depleted sal forests that have been taken over from zamindars.

DVC is co-operating in this effort by establishing demonstrations of good management in selected areas. When the evils of fire, overgrazing and overcutting are eliminated, the ground is soon covered with vegetation and erosion is brought under control.

Holdings in the area are extremely fragmented and scattered. A typical plot is 20 feet wide and 300 feet long. Some are still narrower, and may only be a cent (1/100 acre) in size. They usually run with the slope and make it necessary to plough up and down the hill. This causes heavy sheet erosion. Run-off induced by down-slope ploughing increases the size of gullies that often encroach from below.

WATER DISPOSAL

As long as land remains in this condition, it is not practicable to establish the usual type of water disposal system with terraces, outlets and contour rows. To do so would further cut up the already small and scattered plots. The only remedy is to combine the planning of water disposal measures with a type of consolidation of holdings that does away with the present plots and establishes completely new ones with boundaries parallel to the terraces.

This means that a farmer cannot accomplish conservation farming by himself. He and his neighbours

must plan and work together under the guidance of a soil conservation technician.

On one block, where the consolidation of holdings has been legalized, it was necessary to make precise measurement of each of the numerous small plots that made up the new holdings. This was a costly operation. If the necessity for these measurements could be eliminated, the process of legalizing the consolidation of holdings would become relatively simpler and inexpensive.

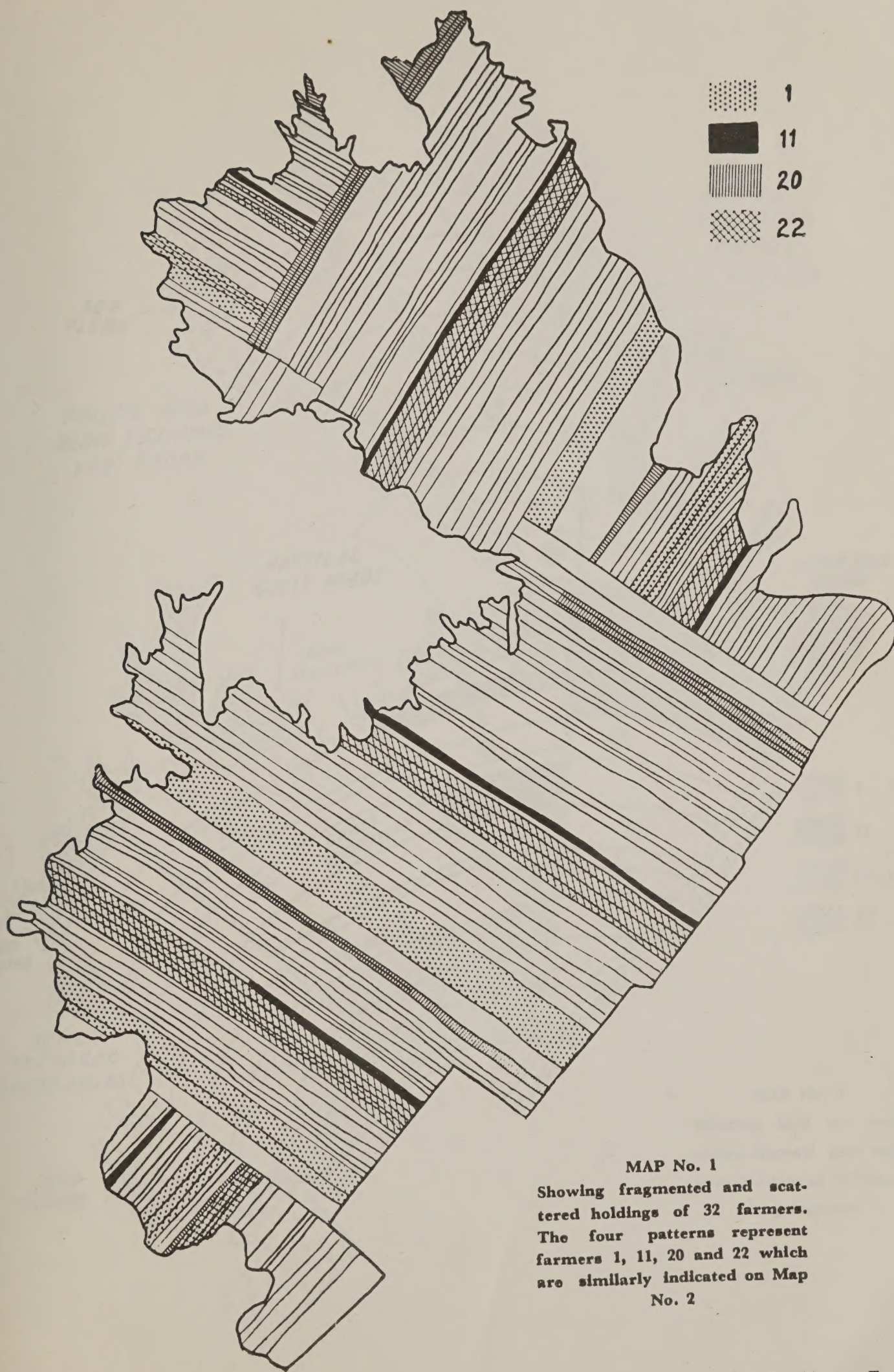
CONSOLIDATION AND CONSERVATION

On pages 10 and 11 are two maps of a 50-acre block of upland in Nawdiha village near Hazaribagh. Map No. 1 shows how the area looked before treatment, and Map No. 2 is after the treatment. The long, parallel lines on Map 1 are the boundaries of 204 plots belonging to 32 farmers. On each map, four of these farmers are represented. Map 1 shows how their fields were scattered before planning. Map 2 shows how these fields have been consolidated. Map 2 also shows the soil conservation plan for this land, and how all the 32 farmers have rearranged their properties to fit in with their plan.

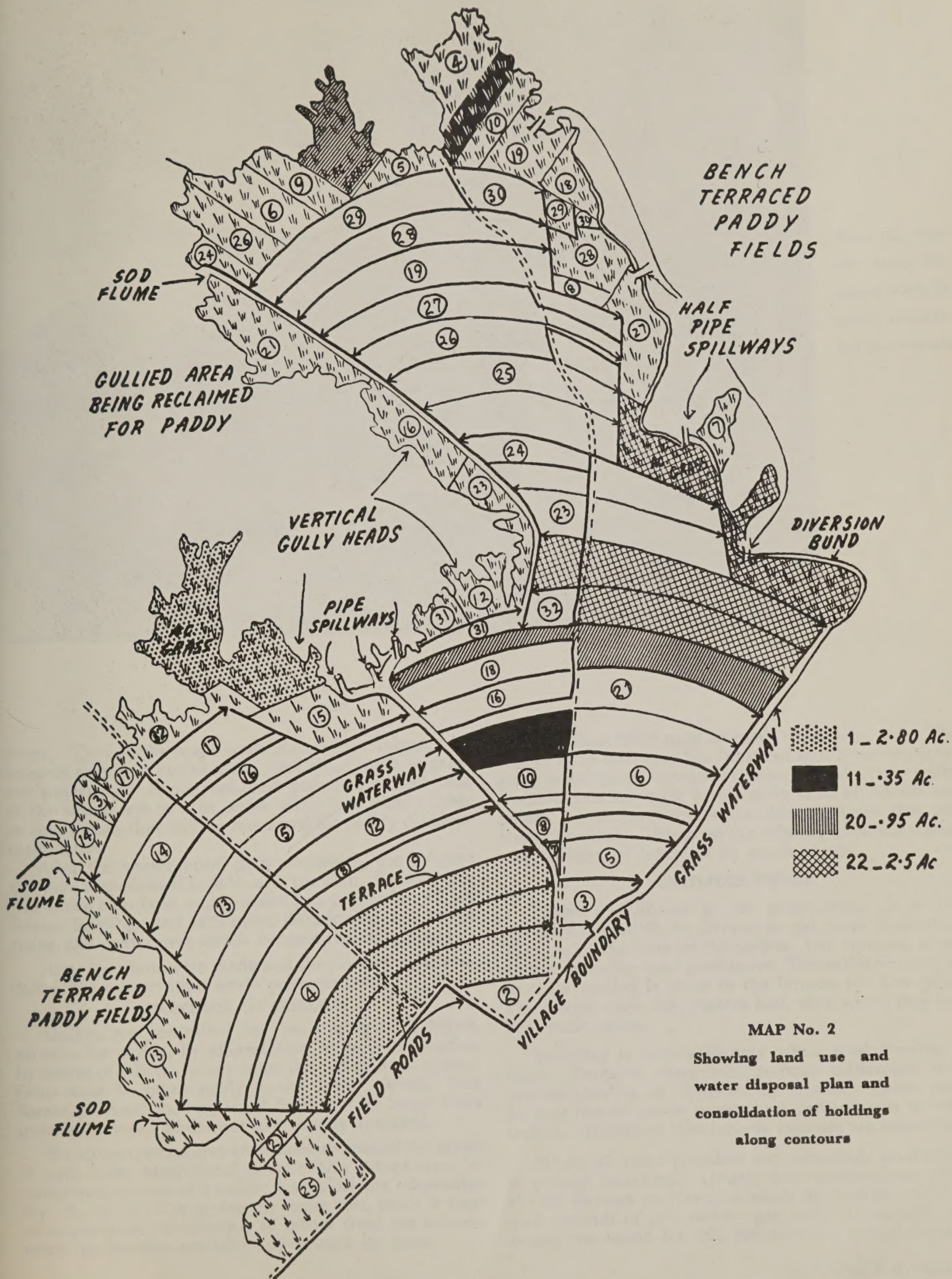
The plan was made just as if all the land belonged to one man. An area next to the gullies was planned for permanent meadow and the rest of the land for rotated

Land destroyed by erosion. Unless effective steps are urgently taken to stem erosion, the usefulness of reservoirs will be short-lived





MAP No. 1
 Showing fragmented and scattered holdings of 32 farmers.
 The four patterns represent farmers 1, 11, 20 and 22 which are similarly indicated on Map No. 2



MAP No. 2

Showing land use and
water disposal plan and
consolidation of holdings
along contours



How the run-off from the upper levels is safely taken to the lower levels

crops. Two access roads were planned on ridges, and terraces were laid out to drain from these roads to grassed waterways. Structures were provided at the ends of the waterways to take water safely into paddy fields or into gullies that will be reclaimed for paddy development later.

After the conservation plan was made, the properties were consolidated to fit in with the plan. Each farmer was given crop land and grassland in proportion to his former holdings, and each owner contributed land to the roads and waterways which became common property.

After the plans were made and the properties consolidated, the conservation works were executed.

CONTROL OF GULLIES

Gullies are controlled by reclaiming with bench terraces for paddy, by afforestation, or by submergence by means of a dam. In any case, the run-off from upland fields must be taken safely to the lower levels. Sod flumes are used for very small flows, but for larger flows more substantial structures are usually required.

Sometimes, structures are needed to control the grade of gully beds. Mechanical works of this nature must be considered as more of a public than a private responsibility. So far, DVC is paying the entire cost, but it is hoped to get some contribution of labour from the farmers when the benefits are fully appreciated by them.

A constant effort must be made to reduce costs. The cost of drop spillways has been reduced by using corrugated metal sheets instead of masonry for the cross walls. Earth bunds are built across gully beds at constricted points, where they divert the flow to areas that are already sodded. This gives the effect of a sodded waterway, broken at intervals by small ponds.

FERTILIZER NEEDS

Fertilizer is the key to the programme. It is the incentive offered to the farmers to get them interested. They build the terraces themselves, but terraces alone do not make the land productive. The entire quantity of fertilizer needed is given to the farmers the first year. The second year, they receive half, after which they first buy their share.

Fertilizer is profitable only when good farming is done. Terraces, along with contour cultivation, help prevent the loss of fertilizer by erosion. Crops must be kept free of weeds; insects and diseases must be controlled. Rotations that include legumes are important.

When all these practices are combined, production is greatly increased. Under their conservation plan, the 32 farmers at Nawdiha made an average yield of 14.6 maunds of *gora* paddy per acre. This, with the straw, was worth Rs. 123 per acre net, after deducting

the cost of seed, fertilizer and insecticides. Before the plan, these farmers grew *sarguja* one year and *gora* paddy the next, and left the land fallow for two years. They estimated their yield of paddy at eight maunds and *sarguja* at two maunds per acre. The total value of the two crops was Rs. 120 per acre. Thus, in four years, they had made slightly less than they do now with only the first crop grown under their conservation plan.

BETTER INCOME

The 124 farmers at Lupung village did even better on their 24-acre block. They planted a mixture of *gora* paddy and *arhar*, and their average yields were 18.5 and 7.4 maunds per acre, respectively. This grain, together with the paddy straw, was worth Rs. 311 per acre. After deducting Rs. 55 for seed, fertilizer and insecticides, they had a net labour income of Rs. 256. This compares with an estimated Rs. 40 per acre for the *gondli* they had grown in the previous year.

Pastures and meadows can give a good profit if fertilized. There are two main problems. One is to protect the grass from overgrazing. Fencing is expensive. While farmers might be expected to guard the grass as they do their crops, they have so far shown no interest in this. Another problem is that the quality of

the cattle is so poor that farmers cannot afford to spend much money on producing feed for them.

It is encouraging that the farmers have been willing to put some of their land under grass, and that some of them have cut and fed it to their cattle. As the National Extension Service programme for upgrading the cattle progresses, it may become more feasible to spend money on the production of feed. Both the cattle and the land need good grass. Grass roots improve the soil.

MORE PROFITS

With an investment of Rs. 43 per acre per year in fertilizer, a yield of 200 maunds of grass and legumes can be expected. If this fodder is fed to good cattle, it is worth 75 nP per maund, or Rs. 150 per acre. This would be a profit of Rs. 107 over the cost of fertilizer.

Costs have been figured for the conservation practices, including consolidation of holdings, on an area of 507 acres near Hazaribagh, consisting of 337 acres of crop land and 170 acres of grassland. A large proportion of this land was surrounded by gullies. The average cost per acre of each practice for crop land and grassland, and the average cost per acre when the entire area of 507 acres is taken, are given in the table on the next page.

Contour ploughing
-one way of ward-
ding off erosion.
A surveyed terra-
ce line is plough-
ed in preparation
for moving earth
to form terrace
channel and ridge





Moving earth with a board drag (Karha) to form channel and ridge of a broadbase terrace.

<i>Treatment</i>	<i>Cost in rupees per acre of</i>		
	<i>crop land</i>	<i>grass- land</i>	<i>total land</i>
Fencing		250	83.75
Fertilizer	50*	43	47.65
Seed	8	25	13.70
Establishing a meadow		55	18.43
Terracing	45		29.93
Establishing grass waterways	18		11.97
Stabilizing gully-heads	6	3	5.00
Structures	7**		4.66
<i>Total</i>	134	376	215.09

* Includes rupees seven for insecticides

** Includes structures for stabilizing gully-heads, but not the structures in the gully beds

The most expensive single item was the fencing. The reason for this high cost is that the areas fenced are very small and irregular. This cost could be eliminated entirely if the farmers would guard their grassland against grazing as they guard their crop land. Most of the cost for grass seed could be eliminated by having a village co-operative seed nursery.

Except for structures, fertilizer, seed and insecticides, all the other costs are for labour that the farmers could provide themselves. Fertilizer, seed and insecticides are charges against crop production, since they immediately return a good profit on the investment. All that the farmers need, in order to get started in using these materials, is readily available credit. So the only necessary out-of-pocket cost for protecting the land against erosion is approximately rupees five per acre for structures.

In 1954, conservation treatment, including consolidation of holdings, was applied on only 17 acres. This was the year the DVC Extension staff began to shift from demonstrations which were purely agricultural in nature to demonstrations of soil conservation farming. The area treated in 1955 was 245 acres and, in 1956, it was 837 acres. The target for 1957 is 1,100 acres.

Holdings were consolidated on 125 acres in 1955 and on 400 acres in 1956. The target for 1957 is 687 acres.

The operational unit for the work is a centre under the direction of an Extension Agent. The standard staff for a centre consists of four field assistants, two *amins* and two chainmen, although this has varied to some extent as new personnel have been recruited and trained. In the area of operations near Hazaribagh, there were four field assistants per centre in 1955 and six in 1956. The other staff was about the same for the two years.

DECLINE IN COST

The area treated and consolidated by a centre was 63 acres in 1955 and 200 acres in 1956. The target for 1957 is 250 acres for a standard centre. This shows that the cost on staff is gradually being reduced as the personnel gain experience and competence. This cost is also related to the amount of supervision that the farmers require. The cost will come down rapidly when

the farmers adopt better farming practices as a matter of habit.

No attempt has been made to place a money value on the benefits of conservation farming. It is well known that the benefits are large. For one thing, it offsets the enormous cost, in terms of loss, of *not* conserving the soil. It pays the farmer a good profit on his investment. This increases his purchasing power and thereby provides wealth for business and professional people. This also increases the tax base.

WHAT CONSERVATION MEANS

Soil conservation farming helps protect expensive reservoirs and other public works. It saves land from destruction. Who can say what an acre of land is worth. Only if the land is protected and improved can people have good harvests and plenty to eat. And only then they grow strong in body and mind and spirit, and be able to build the great nation that everybody is hoping for and working for.



The reward of all labour : a good crop resulting from a combination of soil conservation practices.

I am told that the cost of the land development here is about 200 rupees per acre for 2 years. One-half the cost is borne by the DVC. The first year the cultivator is given all the necessary fertilizer for good crops and the second year he gets one-half the cost of the fertilizer. During the first year the cultivator furnishes only some of the labor.

I am told that good soil for dryland crops here now sells for around 80 to 100 rupees per acre, whereas good paddy land sells for around 1,000 rupees per acre.

On the terraced land they grow upland rice, millet, and pigeon peas. While the crops are on the animals are kept off the area, but during the season without crops the soil is not protected from heavy grazing.

The grass in the gullied area is used by the cultivators for cut fodder and some of the woody plants for fuel. The cultivators now get much more feed for their animals than formerly; but, of course, they need to cut that within the protected areas by hand. Around the tops of the gullies diversion terraces have been built to collect the water and to lead it into prepared outlets. Many of these gully heads have been planted to pangola.

The cultivators in this region have one very bad practice. They don't use the cattle dung for fuel since they have enough brush and small trees. They collect it, dry it, burn it, and put the ashes on the fields.

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I am much impressed with the good work here because land reallocation is absolutely essential for a good water-control system on these upland soils. I am sure it will take a lot of patience to get the confidence of the cultivators so they will agree to the consolidation. The scheme of partial consolidation, rather than full consolidation, is very sensible indeed. But I'm sure the so-called "soil survey" was of little use in the work.

We now go back to the offices of Dr. Sen for tea and talk with the whole group. I am very amused at the young geologist here who tries to tell me that he has no real opportunity to apply what he has been taught. This poor lad! This area is a geomorphologist's paradise, if he will really work.

After dark I go back to my room and change for dinner chez Hull, who has been with me all day.

I am quite well impressed with Dr. Sen who is in charge of the conservation work here. Of course, I cannot say how much of it is due to him and how much is due to Mr. Hull. The conservation work looks good but I doubt that the soil survey helped much. I am beginning to be more and more convinced a scheme something like that used by Dr. Agarwal is the one to recommend.

After dinner and some chitchat I go to bed at 10:30.

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The Soil Conservation Station of the DVC has 156 acres. Most of these are upland and the area includes some shrubby wasteland. The first thing I am shown is another big battery of runoff plots.

The trials here have shown that graded terraces are very much better than the contour bunds formerly used. This practice a little bit more than doubles crop yields and a rather light application of fertilizers gives another doubling.

I am told that in the runoff plots maize planted up-and-down the slope gives higher yields but more soil loss than maize planted on the contour, because of the waterlogging back of the ridges.

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K-2422. Jan. 17, 1958. Near Hazaribagh. Young trees, mostly sol, on area of old farmed soil guarded since 1952. Soil much improved with thin A_{00} and 2 in. of granular A_1 .



K-2423. Jan. 17, 1958. Near Hazaribagh. Young termite mound.
 near Hazaribagh. Jan. 17, 1958. Near Hazaribagh. Young termite mound.
 E. Kellogg, photo from right. January 17, 1958.

II

K-2422

K-2422. Jan. 17, 1958. Near Hazaribagh. Young trees,
mostly soil, on area of old farmed soil, graded since
1955. Soil much improved with thin A₀ and 2 in. of
granular A₁.

VI

K-2423

K-2423. Jan. 17, 1958. Near Hazaribagh. Young tree-like mound.



With soil surveyors near Meru, 8 miles east of Hazaribagh.



Experimental plantings on Deochanda Experimental Station of the DVC, near Hazaribagh. Dr. Sen at extreme left; Hull 4th from left; Charles E. Kellogg, third from right. January 17, 1958. (S.P.R.)

29

With soil surveys near Main, 8 miles east of Haverhill.

30

Experimental plantings on Deschampsia Experimental Station of the DVC,
near Haverhill. Dr. Ben at extreme left; Hall 4th from left; Chamberlain
E. Kellogg, 4th from right. January 17, 1958. (S.P.R.)

I tell my Indian friends that I am beginning to think that I shall need to promote a Society for the protection of the soils in India against any more runoff plots. This technique has been copied directly from the United States and the establishment of these plots has taken a great deal of their research money.

They tell me that where bunds are placed on the contour it is better to have them with open ends because of the danger of waterlogging.

From the data here I estimate that yields of maize are about 52 bushels per acre with 80 pounds of nitrogen and 40 pounds of P_2O_5 .

They have a nice collection of grass plots with about 45 grasses and 22 legumes under study.

I see some stripcropping with upland paddy, maize, peanuts, and 3 years of grass. The strips are laid out on the contour with grassed waterways. This seems to work fairly well. Although there are no terraces, the peanuts and the maize are ridged.

It is interesting here that the southern slopes of the low mountains are noticeably steeper than the north-facing ones. I suspect this is because of heat and thinner vegetation, although it may be due partly to the fact that the steep slopes are directly in the path of the monsoons.

I pass a small village where sawyers are making boards by hand. These are used for packing mica from the nearby mines. I am told that the workers get 1 and 6/16 rupees per day for 8 hours. It seems very bad to have this hand labor in an area devoted to the production of electric power; but of course if the saws were electrically operated most of these men would be unemployed.

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I am taken to an area where reforestation was started in 1952. A badly grazed area was enclosed. Almost at once the soil comes out from sprouts. These are thinned and the open places planted with both soil and exotic species. In this short time the surface soil has been much improved. There is a thin A_{00} with about 2 inches of granular soil beneath that is well started toward mull.

I drive by a village made by the DVC for the resettlement of cultivators from the lowlands that would be flooded. But these cultivators don't like the dryland because they are used to paddy. Only about two-thirds of the houses are occupied. Some of these people work in the forest and they are permitted to use the thinnings of the forest for fuel.

Prior to reforestation this soil had certainly suffered considerable erosion. The stone line is very near the surface in places. I look at another planting started in 1956 that has come through two rainy seasons. The trees are 4 to 10 feet high. Many of these were planted as well-grown seedlings out of the nursery. Here much of the soil had been eroded down into the B_2 and the surface soil is very hard. Still some of the species persist through the dry season. I should say these upland soils here are somewhat nearer to Non-Calcic Brown than to Red Latosol.

Now I am driven to the station for fish culture. For some reason they have not been able to get the fish to reproduce here so they buy tiny carp and grow them in small tanks. After about 7 weeks these are released to the reservoir pool. They gain about 10 pounds a year and

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Prior to reforestation this soil had certainly suffered considerable erosion. The stone line is very near the surface in places. I look at another planting started in 1956 that has come through two rainy seasons. The trees are 4 to 10 feet high. Many of these were planted as well-grown seedlings out of the nursery. Here much of the soil had been eroded down into the B₀ and the surface soil is very hard. Still some of the species persist through the dry season. I should say these upland soils here are somewhat nearer to Mon-Calec Brown than to Red Latosol.

Now I am driven to the station for fish culture. For some reason they have not been able to get the fish to reproduce here so they buy tiny carp and grow them in small tanks. After about 7 weeks these are released to the reservoir pool. They gain about 10 pounds a year and

attain a large size in something like 36 months. The fish are taken by licensed fishermen in nets. The large fish are worth about 30 rupees and the DVC is given 10 rupees of this.

I am then taken to a special research farm for partially submerged soil. First of all, it is worked out by the engineers what soils will be exposed during what months after the end of the monsoon and as the water rises again. To make use of the soils below the upper limit of the pool down to the pool lines at various stages, experiments are being run with different sorts of crops. Some are seeded and grown as the water goes down; whereas others are seeded and grow in the rising water. With careful planning they are able to get two crops in many places and, with irrigation, even three row crops in some places.

This is a very interesting station. I see some of the tallest rice I have ever seen in my life. I am told it may grow to 15 or 20 feet in height. It is planted before the water starts to rise then keeps on growing as the water comes up.

Besides the research station these men have some demonstration farms for cultivators who lease the land at low rates from the DVC.

I notice that some of the soils have calcium carbonate nodules but there seems to be no salt.

At the station and on the demonstrations they are also working out rates and amounts of fertilizers as well as dates of sowing. I am told that sugarcane can be used even where the water gets to be a foot deep. They are also studying the effects of the silt entering the reservoir with the thought that it will gradually improve the

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structure of the soil and perhaps its fertility.

I look quickly at a heavy cracking soil that is poorly drained much of the time. It has an olive color, is calcareous, and has many small ferro-manganese concretions.

We have tea at this station and go back to the town. We drive by many of these paddy fields that are a mixture of gray, brown, and black.

I get some money at the bank and go back to the rest house for lunch with Mr. Klemme, formerly of the University of Missouri, who is located at Calcutta on an ICA college team for West Bengal.

We prepare to leave by car for Calcutta after lunch. The bearers here have been very nice to me and now present me with two bouquets of flowers. (But I don't know what to do with them.) At 3:10 p.m. we drive east toward Bagodar.

I see a great deal of dry, overgrazed, shrubby pasture. A part of the upland is in dryland crops and there is some paddy on the lower easy slopes. A few small fields or plots, irrigated from wells, are protected by brush fences.

(My driver is certainly stepping on the gas! Apparently he has been told to get to the next rest house before dark. But I slow him down.)

There is some dissection with gullies, like those we saw on the demonstration farm. The bottoms of the larger ones have been smoothed and made fit for paddy.

We cross a tributary stream that has already been cut down to the country rock. At lower elevations there are some shallow

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Patna
Calcutta
Trip

branch gullies with paddy in the bottoms.

We cross another stream. The soils in this area seem to be Red Latosols. Part of them are quite hilly and are covered with scrub forest. Part of the land is in reserve and I see some trees of fair size.

We drop down into a broad valley used for paddy with thin Red Latosol on the margins. Not counting the stony hills, there seem to be three main levels of land form here. On the intermediate level, the regolith seems quite deep and apparently there are two stone lines. At the margins of the streams there are deep gullies in this regolith.

We cross the Jamunia River, which has 12-foot cut banks. In one mile we come on to the Grand Trunk Road between Delhi and Calcutta at Bagodar. Some of the high jagged hills may be basaltic, although I doubt it. The main country rock appears to be granitic gneiss and schist. As we go along the road, I see a high jagged mountain to the left with an important temple at the very top.

Forty miles west of Maithon the soils appear to be a bit more moist. There are jagged hills to the north but a high percentage of paddy along the road on undulating red soil.

We pass some low, bold bouldery hills and go on to quite red soil that is not in paddy.

We pass Godinpur, an administrative headquarters, and turn off the road to the left to the rest house at Maithon Dam. We arrive at the rest house at 5:45 p.m. where I meet several people as follows:

- S. K. Mukherjee, the agricultural chemist for West Bengal
- S. Digar, the soil correlator for the laterite zone, has been with us today.
- G. B. Biswas and K. C. Majumder, field soil scientists of the Center working out of Calcutta.

branch gullies with paddy in the bottoms.

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S. Dugar, the soil correlator for the laterite zone, has been with us today.
G. B. Biswas and K. C. Majumder, field soil scientists of the Center working out of Calcutta.

They show me some maps on a scale of 1 inch equals 1 mile. These have from 2 to 5 soil types at about the level of the great soil group or subgroup. Since they have started their correlation work by broad soil regions, areas of Alluvial or "Red" soils are left blank on the map since these boys are responsible for only "laterite soils"! This kind of foolishness must be corrected and the correlation areas arranged along State boundaries.

Just as I am ready for dinner, the chairman of the DVC Board, Mr. P. S. Rau, sends his assistant to tell me that I am to move into his quarters. This takes some time. At the chairman's quarters I meet a consulting engineer from the United States, Mr. A. M. Komora, who graduated from the University of Michigan in 1924.

We then go for a pleasant dinner chez Komora. I have never seen a home with so many unrelated objects d'art of poor to excellent quality all crowded together in great shelves and cupboards.

I take a shower and to bed at 10:00.

January 18: Mr. Rau has the adjoining room to mine and gets up at 5:30 for an early train. He makes a noise like a herd of elephants in the canebrakes. So I am up at 6:00 a.m. ready to go at 7:00. This is a bright, warm, sunny morning with smog. The gardens here are very beautiful, especially the dahlias.

We leave at 7:40 a.m. and are soon in Barkar and the State of West Bengal. We drive on the main road to Asansol through a large industrial area that has a disorderly mixture of new and very old. Beyond, the soil is used mostly for paddy, with some high bunds, up to the crest of the swells. Previously the rickshas I had seen were

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attached to bicycles but here many of them are pulled by men walking between 2 poles. Some of them run. Certainly this method for transport is degrading to the workers.

As we move on beyond Asansol the traffic is heavy. We are still on the Grand Trunk Road to Calcutta. I find it hard to tell much about the soils here. Some of the low lands are alluvial.

The upper ones have been dug over in the past for bricks and part of the area has been reshaped for paddy. All of the soils that have been under paddy for very long are pale brown or gray.

We stop in an undulating overgrazed shrubby area about 127 miles west of Calcutta. At the margins I see outcrops of laterite. The soil is said to belong in the Bijohnagar series or a "reddish-yellow murrum laterite."

- | | | |
|----------------|----------|---|
| A ₁ | | Essentially none. |
| A ₂ | 0 - 12" | Reddish yellow (7.5YR 6/6) light sandy loam; firm and massive in place; slightly vesicular. The soil digs out in brittle easily friable fragments. I see a few medium dark reddish-brown concretions. |
| B ₂ | 12 - 29" | Finely mottled reddish-yellow and red, concretionary clay (murrum) with very dark reddish-brown ferro-manganese concretions of medium size. The soil is quite hard in place and quickly dries to very hard. Pick marks have a red streak (10R 5/8). The lower boundary of this horizon is wavy and varies from 6 inches deeper to 6 inches shallower. |
| B ₃ | 29 - 46" | Fairly to moderately mottled yellowish-red and red heavy sandy clay. The soil is massive in place. There are a few cracks and this material also hardens considerably on drying. |
| C ₁ | 46 - 50+ | Mottled strong brown, yellowish-brown, and white weathered sandstone with a sandy clay texture. |

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miles west of Calcutta. At the margins I see outcrops of laterite.

The soil is said to belong in the Bijoynagar series or a "reddish-

yellow murum laterite."

A1

Essentially none.

A2

0 - 12"

Reddish yellow (7.5YR 6/6) light sandy loam; firm and massive in place; slightly vesicular. The soil digs out in brittle easily friable fragments. I see a few medium dark reddish-brown concretions.

B2

12 - 20"

Finely mottled reddish-yellow and red, concretionary clay (murum) with very dark reddish-brown ferro-manganese concretions of medium size. The soil is quite hard in place and quickly dries to very hard. Pick marks have a red streak (10R 5/8). The lower boundary of this horizon is wavy and varies from 6 inches deeper to 6 inches shallower.

B3

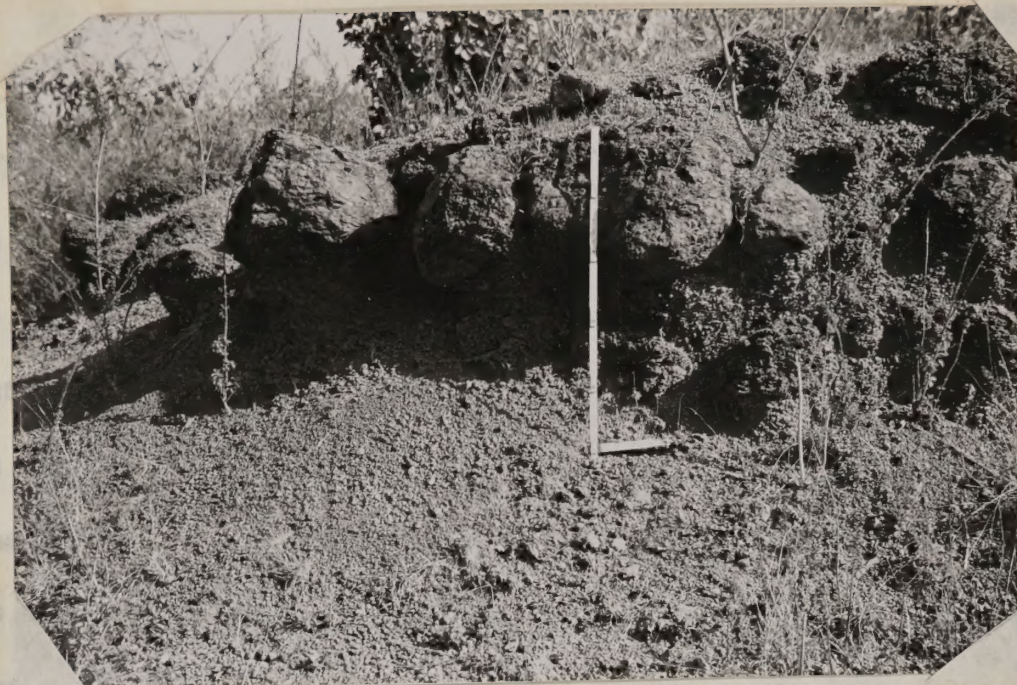
20 - 46"

Fairly to moderately mottled yellowish-red and red heavy sandy clay. The soil is massive in place. There are a few cracks and this material also hardens considerably on drying.

C1

46 - 50+

Mottled strong brown, yellowish-brown, and white weathered sandstone with a sandy clay texture.



K-2424. Jan. 18, 1958. 127 miles west of Calcutta. Laterite at margin of area of Ground-Water Laterite soil (Bijoynagar series) that is being gullied.



Between the soil on the little plateau and the old gully, there is a strip of soil irrigated by the old gully. K-2425. Jan. 18, 1958. 127 miles west of Calcutta. Low level, near old Ground-Water Laterite soil. Old wide gully smoothed for paddy about 25 feet lower than original level.

I cannot be sure of the genetic relations between A₂ plus B₂ and B₃ plus C. I rather suspect that the two upper horizons are from different material.

The roots go down into the B₃. The slope here is about 3 percent. I think this soil belongs with the Ground-Water Laterite soils. I am told that in the monsoon the water table is at the top of the B₂ but that now in the dry season it is about 80 feet deep. The original vegetation was probably forest, mainly sol and palas, but now there are grasses and some secondary thorn bushes. It appears that this soil has not been farmed.

At the edge of this soil area gullies are slowly working into the plateau. At the margins I see exposures of massive, cracked pisolithic laterite. The concretions accumulate in the bottoms of the gullies. Here they are scraped up and used for road material.

As one goes down the slope of these gullies, the bottoms seem to be fairly well stabilized at a level about 20 to 25 feet below the little plateau. These bottoms are smoothed off and used for paddy. The surface soil seems to be mostly of material described above as C₁. The murrum has been removed. The soil cracks into hexagons about 6 to 12 inches across. I see many of these little fields separated by bunds about 15 inches high on the upper side and 3 feet on the lower side.

Between the soil on the little plateau and the actual gullies, there is a strip of soil truncated by sheet erosion with laterite crust at the surface.

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and 3 feet on the lower side.

Between the soil on the little plateau and the actual gullies,

there is a strip of soil truncated by sheet erosion with laterite

crust at the surface.

We drive on about 2 miles further and look briefly at a profile of the Sankapur series. It is about 7 feet down to the same C₁ as seen in the Bijohnagar series. Above the C₁ is red (2.5YR 5/8) concretionary clay with blocks of laterite rock imbedded in it at all depths. These honey-combed fragments are typical of the hardened B₂ of Ground-Water Laterite. The fragments are mainly red with black, yellow, and strong red mottles. We are looking at the soil on a tiny plateau. Gullies have cut into it on all sides. Some new soft laterite may still be forming at great depth. I think this is a secondary soil, formerly eroded, and then again covered with murum and the old boulders of laterite. The surface is undulating but there is a new active erosion cycle. The area has grass and scrubby woodland.

We continue on east. I notice that the road workers here are thin and weak. They don't work hard because they cannot; yet with their low wages they probably do not get enough to eat.

We travel a long way on very gently sloping, almost flat, plains with paddy on the alluvial soils. I am told that this soil gives only about 500 pounds of rice to the acre.

I see very few bullock carts on this road and more trucks. I suppose it is too far to Calcutta to use the bullock carts as a main transport of food for that great city.

82 40 - 964
Sandy clay, mainly red (2.5YR about 4/8) mottled with gray and other shades of red, yellowish-red, and reddish-brown. This hardens upon drying and is only fairly hard in this pit made only a few days ago. The soil digs out in fragments that break easily into small, very hard subangular blocks. It contains some small black concretions.

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I see very few bullock carts on this road and more trucks. I suppose it is too far to Calcutta to use the bullock carts as a main transport of food for that great city.

We pass a new town with nice looking apartments for steel workers, and then come onto a higher undulating terrace with protected scrubby forest. This area is also entering a new erosion cycle that exposes laterite crusts at the margins.

At 111 miles west of Calcutta we stop to look at the soil. This is called the Bistupur series or reddish-yellow murum laterite. The parent material is very deep and the pit is made to 8 feet. The surface is very gently sloping. During the monsoon the water table is about 2 feet and in the dry season it is very deep. This soil I should call a good example of the Ground-Water Laterite group.

- | | | |
|--------------------|-----------|--|
| A ₁ (?) | 0 - 1/2" | Very pale brown (10YR 6/3) highly vesicular sandy loam with many insect holes. |
| A ₂₁ | 1/2 - 12" | Yellow (10YR 8/6 dry, 7/6 moist) heavy sandy loam; finely and strongly vesicular. The soil is massive in place, of low bulk density, and digs out as an easily powdered-fine mass. |
| A ₂₂ | 12 - 23" | Brownish-yellow (10YR 6/6) heavy sandy loam to sandy clay loam with very faint small mottles of faint reddish-yellow. I see a few small reddish concretions in the lower part. |
| B ₁ | 23 - 40" | Light gray sandy clay with medium mottling with red. This soil is said to harden upon exposure. It is massive in place but easily falls into irregular blocky that is friable with difficulty. There are some concretions that give red streaks in the cut. The lower boundary is wavy and varies here in the pit between 34 and 46 inches. |
| B ₂ | 40 - 96+ | Sandy clay, mainly red (2.5YR about 4/8) mottled with gray and other shades of red, yellowish-red, and reddish-brown. This hardens upon drying and is only fairly hard in this pit made only a few days ago. The soil digs out in fragments that break easily into small, very hard subangular blocks. It contains some small black concretions. |

We pass a new town with nice looking apartments for steel workers, and then come onto a higher undulating terrace with protected scrubby forest. This area is also entering a new erosion cycle that exposes laterite crusts at the margins.

At 11 miles west of Calcutta we stop to look at the soil.

This is called the Biscupur series or reddish-yellow laterite. The parent material is very deep and the pit is made to 8 feet. The surface is very gently sloping. During the monsoon the water table is about 2 feet and in the dry season it is very deep. This soil I should call a good example of the Ground-Water Laterite Group.

Very pale brown (10YR 6/3) highly vesicular sandy loam with many insect holes.

A₁ (?) 0 - 1 1/2"

Yellow (10YR 8/6 dry, 7/6 moist) heavy sandy loam; finely and strongly vesicular. The soil is massive in place, of low bulk density, and digs out as an easily powdered-fine mass.

A₂ 1 1/2 - 12"

Brownish-yellow (10YR 6/6) heavy sandy loam to sandy clay loam with very faint small mottles of faint reddish-yellow. I see a few small reddish concretions in the lower part.

A₂₂ 12 - 13"

Light gray sandy clay with medium mottling with red. This soil is said to harden upon exposure. It is massive in place but easily falls into irregular blocks that are friable with difficulty. There are some concretions that give red streaks in the cut. The lower boundary is wavy and varies here in the pit between 3 1/2 and 4 1/2 inches.

B₁ 23 - 40"

Sandy clay, mainly red (2.5YR about 4/8) mottled with gray and other shades of red, yellowish-red, and reddish-brown. This hardens upon drying and is only fairly hard in this pit made only a few days ago. The soil digs out in fragments that break easily into small, very hard subangular blocks. It contains some small black concretions.

B₂ 40 - 90+



Looking at Ground Water Laterite soil 127 miles west of Calcutta.
(Bijoynagar series). January 18, 1958. (S.P.R.)



Looking at Ground Water Laterite soil 111 miles west of Calcutta.
(Bistupur series) January 18, 1958. (S.P.R.)

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Looking at Ground Water laterite soil 127 miles west of Calicut.
(Bistapur series). January 18, 1958. (S.P.R.)

32

Looking at Ground Water laterite soil 111 miles west of Calicut.
(Bistapur series). January 18, 1958. (S.P.R.)

Here I notice a good deal of tarantula activity but only about two tarantula wounds per acre.

We drive on and are soon over a very gently undulating alluvial plain with some dissection. There are many small fields for gully. Now, of course, the fields are very dry.



Water laterite. This is a brown laterite soil.

K-2426. Jan. 18, 1958. 111 miles west of Calcutta.
Landscape on Ground-Water Laterite soil. (Bistupur series).
Local alluvium is mixed in the soil surface.

A₁ 0 - 7" Light gray when moist, is nearly white when dry, sandy loam, mottled with pale brown, massive in place and breaks out in irregular vesicular pieces that are brittle and fairly easily friable. The soil has many roots.

A₂ 7 - 13" Sandy loam to sandy clay loam, light gray to nearly white when dry, moderately mottled with pale brown. When dry the soil is hard and massive. It digs out in a mixture of medium and small blocks, friable when dry. It is plastic when wet.

A₃ 13 - 33" Transitional.

Here I notice a good deal of termite activity but only about two termite mounds per acre.

We drive on and are soon over a very gently undulating alluvial plain with some dissection. There are many little fields for paddy. Now, of course, the fields are very dry and the soil is light brown in color. I suspect considerable lateritic material in the alluvium. I am told that cultivators get about 800 to 1200 pounds of rice per acre.

We then pass by irrigated paddy that is said to yield from 1600 to 2000 pounds per acre. I see also a bit of sugarcane, wheat, and vegetables.

We then pass over some more Ground-Water Laterite soil and a bit farther on, at the 106 milepost from Calcutta, I stop to look at a pit made in an old paddy area of hydromorphic Ground-Water Laterite. This is called the Kuldiha series and also pale-brown lateritic soil.

The soil is nearly flat. It has had some leveling and some local alluvium is mixed in the very surface.

A_{pg} 0 - 7" Light gray when moist, to nearly white when dry, sandy loam, mottled with pale brown; massive in place and breaks out in somewhat vesicular pieces that are brittle and fairly easily friable. The soil has many roots.

A_{2g} 7 - 23" Sandy loam to sandy clay loam, light gray to nearly white when dry, moderately mottled with pale brown. When dry the soil is hard and massive. It digs out in a mixture of medium and small blocky, friable with difficulty. It is plastic when wet.

AB_g 23 - 33" Transitional.

Here I notice a good deal of termite activity but only about two termite mounds per acre.

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The soil is nearly flat. It has had some leveling and some local alluvium is mixed in the very surface.

Light gray when moist, to nearly white when dry, sandy loam, mottled with pale brown; massive in place and breaks out in somewhat vesicular pieces that are brittle and fairly easily friable. The soil has many roots.	Ap_g 0 - 7"
Sandy loam to sandy clay loam, light gray to nearly white when dry, moderately mottled with pale brown. When dry the soil is hard and massive. It digs out in a mixture of medium and small blocky, friable with difficult. It is plastic when wet.	A_{2g} 7 - 23"
AB_g 23 - 33" Transitional.	



K-2427. Jan. 18, 1958. 106 miles west of Calcutta. Landscape of gleyed Ground-Water Laterite soil long under paddy. (Kuldiha series).



K-2428. Jan. 18, 1958. 106 miles west of Calcutta. Serious erosion on D.V.C. irrigation canal made from infertile lateritic earth.

B₂ 33" + Light gray sandy clay to clay, mottled with yellowish-red (5YR 4/6). The mottles are large and the gray matrix is about 60 percent of the total. I see some very large dark reddish-brown to black concretions that are only semi-indurated. The massive soil digs out in large angular, irregular blocks that are hard. This material becomes very hard when dry.

The C horizon is deep and is probably old alluvium. It is said to have calcium carbonate in it at depths below 10 feet. It seems likely that this soil has been under paddy for at least 1000 years and perhaps longer.

I should call this a gleyed Ground-Water Laterite. Nearby I see a part of the new large irrigation canal built by the DVC. Unhappily, this was made out of unstable lateritic material and is eroding very badly. Some of the erosion debris has already worked out 20 to 30 feet into the paddy field.

I am then taken to a rest house for officers of the Central Government, which is maintained by the Central Public Works Department. We have tea and a rather poor lunch; and then a long wait for no purpose whatever. This means that we shall be very late into Calcutta, where we were supposed to have had lunch.

We finally leave about 2 p.m. For 10 miles or so the soil is developed from alluvium over old Ground-Water Laterite. I am told that one crop of paddy yields about 2000 to 2500 pounds per acre. The nearly flat soil is waterlogged for 6 months. The clay content is high and the soil is said to be high in exchangeable

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K-2429. Jan. 18, 1958. About 85 miles west of Calcutta. Man taking bones to market - a great loss of phosphorus to India soils over the years.

Large loss of phosphorus to India
taking place to market - a great loss of phosphorus to India
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IV

K 2429

K-2429, Jan. 18, 1958. About 35 miles west of Calcutta, Man
taking place to market - a great loss of phosphorus to India
soils over the years.

calcium. It digs out in very large clods. I see some small patches of sugarcane and of other crops on small raised fields or plots. Each cultivator here has only about 2 acres so there is a great problem of local employment in the villages during the dry season. Very few will give up their ancestral lands, I am told, to move elsewhere.

The cultivators fish in the canals and in the small ponds with nets. I notice one to three of these ponds per mile on either side of the road. I suspect that these are very deep old clay diggings. Where they must be made, these deep ones are far better than the shallow ones nearer Delhi.

I notice a great deal of rice straw stacked in the villages here. This is said to be a sign of prosperity. I am told that cultivators here understand the value of ammonium sulphate and superphosphate but that most of them lack money to buy fertilizers. I am told that the cultivators use some fertilizer but they apply little farm manure. The fertilizer applications are too small to account for all the nitrogen. Thus we have the old question in the Tropics: From whence comes the nitrogen? Here I should think that part of it at least is fixed by the algae.

We pass the 67 milepost at Burdwan. This large city was flooded by the Damodar River prior to being protected by the DVC works. There is considerable industry here along with many, many people and very heavy traffic.

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We pass some wasteland caused by sand deposits from the Damodar River. This is slowly being reclaimed. I see several deep diggings for brick but not nearly so much land is being ruined by it as near Delhi. Then too, right here there is less hazard of salinity and disturbed areas can be more easily reclaimed. I suspect a great deal of material has been removed from the land here for bricks over the years, partly because I see so much reclamation of borrow pits along the highways and railway grades.

As we drive along, the number of small ponds increases. Many of these are used to irrigate vegetables. Probably the whole level of the land has been lowered by digging.

At 85 miles from Calcutta the soils are somewhat sandier and have better internal drainage. I see some new reclamation of brick diggings for paddy fields.

Just before passing Pundooah we drive along some high land - an old river bed - which now looks like badlands from digging out building sand and clay for bricks.

The trees are larger here and I see more ponds. This Grand Trunk Road seems to go along an old raised river bed. It has about 3 to 6 feet of silt over sand. We then cross more clayey low soil that has been in paddy only for a long, long time.

At 32 miles out I see fine large plantings of bananas. I am told that near the sea they have coconuts.

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We are driving along the bank of the old bed of the Ganga River. At sometime in the past the Ganga changed its course and now flows into East Pakistan. The old bed is now occupied by the Hooghly River, which is a tidal stream. As a result of this change in the Ganga, the salt water is working up from the coast and is making some of the soils unfit for agriculture. My companions are afraid that this problem will get worse. They also feel that any move to divert a substantial part of the water from the Ganga into this old delta in order to push back the salts would cause military difficulty with Pakistan.

The landscape is greener and there are more trees and more kinds of crops. There are so many, many people here - great crowds of them. I wonder how one American soil scientist can stimulate much improvement in a country with all these people when there are hundreds of tasks that need to be done correctly at once.

At about the 25 milepost from Calcutta we enter its suburbs and first drive through the old French area. Then for a long way we roughly parallel the Hooghly River. There are many small craft with single square sails on it. We cross the river and drive along wide streets. But there are no lanes marked on the pavements and everyone wanders where he pleases; consequently the traffic moves as slowly as in a narrow street.

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At 5:45 I am dropped at the Grand Hotel, which seems to be a very expensive one. While cleaning up I get a call from a Dr. Das, who says he is from the agricultural college. After a little difficulty I get him to leave. He tells me that he will see me tomorrow. (Added later: I never saw him again and I am not sure who he was.)

I have dinner alone in the dining room which is very elaborate indeed for Asia and, I suppose, very expensive. The whole hotel is air conditioned now in January. The menu is in French and my waiter speaks Bangali! But we make out.

After dinner I take a short walk on the streets. Never have I seen so many beggars and thieves, unless possibly in parts of Cairo.

January 19: With breakfast over I take a short walk. This is a nice sunny day but with considerable smog. Most of the shops are closed on Sunday. Many shopkeepers have both sheet steel and a special iron grating over the windows! A pond in the center of the town on the main street is used for washing and bathing by many people. The city has nice street cars.

I go over and walk through a large market. Most of the merchants sit cross-legged on the large tables that hold their wares. I see a wide assortment of fruits, vegetables, meats, and grains. Some stalls sell cloth and other goods although part of the non-food stalls are closed.

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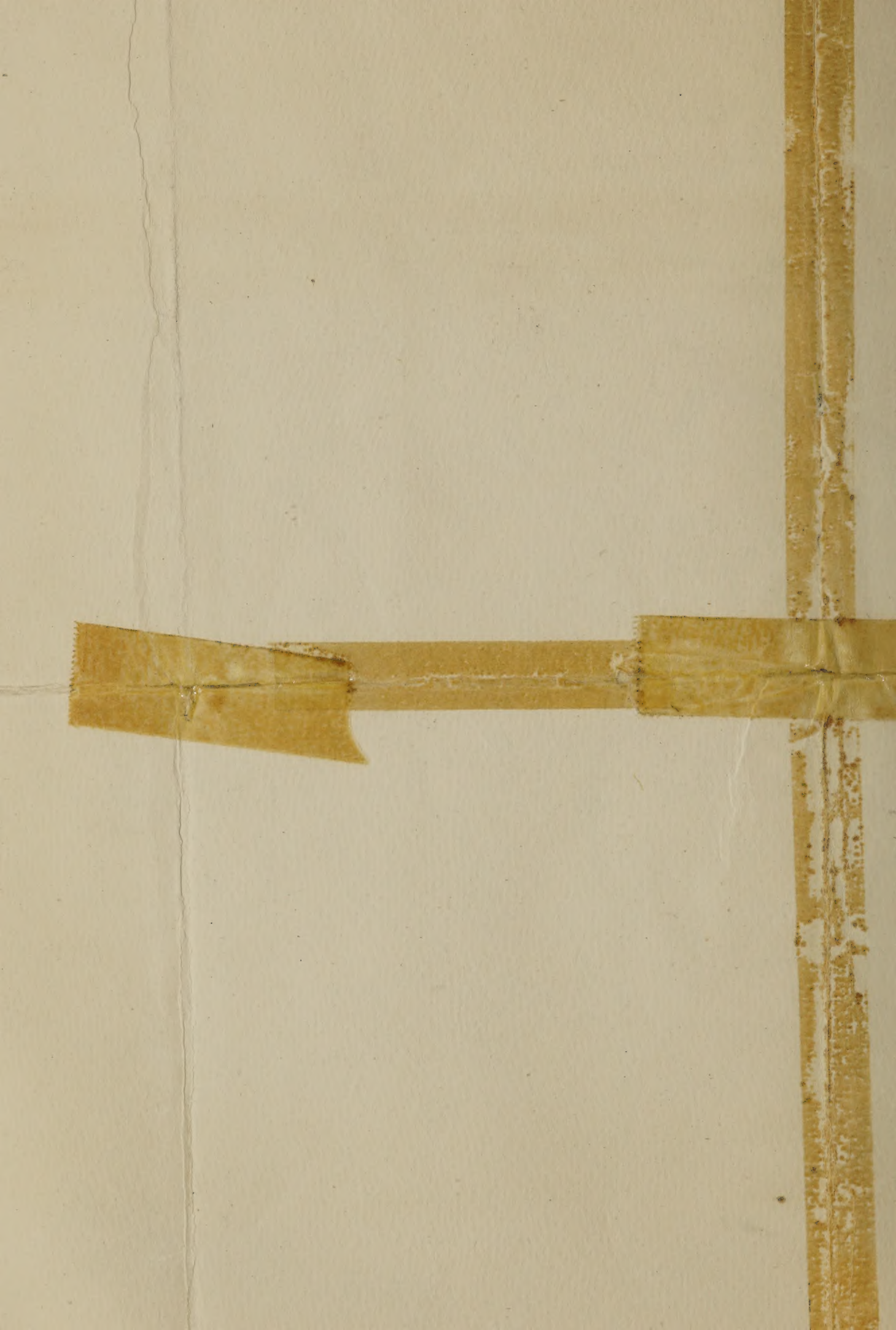
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In the market a local fellow either tries to beg with great vigor or to rob me. Anyway, he makes two lunges for me but I get him off with my cane. Then the local people surround him and take him away. He is probably crazy.

I see a great many nearly worthless trinkets for sale by people who apparently operate only on holidays. These little merchants are squatted on the sidewalk in front of the closed stalls with all of their wares within reach around them.

One certainly has many servants in such a hotel: (1) the room boy who makes bed and brings tea, (2) the sweeper, (3) the baggage handler, (4) the boy who takes the order in the dining room, and (5) the boy who brings the food.

About 10:35 I go for a drive around Calcutta with Dr. and Mrs. Klemme. We go up to the Howrah bridge over the Hooghly River. There are a good many small and medium craft in the river and a few sea-going freighters at dock. I see some rather nice business buildings but here in the center of town there are many people living without homes. At least part of them are refugees from East Pakistan.

I am taken over to the railway station from East Pakistan where hundreds of refugees are camped under the worst conditions I have ever seen. Families live in huts about 5 feet by 6 feet made of mats, cloth, and any other material at hand. There are no sanitary facilities at all. I should like to take photographs

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We drive back to College Street but most of the book stores are closed. A few small handlers have set up booths along the sidewalk in front of the closed stores. But I find nothing of much interest.

I am then back to the hotel for lunch. I notice some fat and wealthy Indians in the dining room. Apparently they have held on to their money from the old days. I am amused to find that a floor show begins. Apparently these are European girls who lost their jobs in Paris.

I leave for the station of the State chemist at 2:15. Along the street I notice a few cows grazing in the central park, comparable to Central Park in New York City.

I meet with Dr. S. K. Murkherjee, and his staff. I notice that he does all the talking and answers all the questions. In West Bengal he recognizes (1) laterite soils, (2) red soils, and (3) alluvial soils, which are subdivided by river systems. He says these three main groups are "subdivided" into series. He shows me field sheets on village plats at 16 inches equals 1 mile.

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When completed these are brought to the headquarters and reduced in scale to 1 inch equals 1 mile. He shows me a new published map at a scale of 2 miles equal 1 inch. He says that his group lacks money for printing and may publish the maps on an even smaller scale. But for use in the field by extension workers and others he plans now to get about 500 copies of the field maps in black-and-white at 16 inches equal 1 mile. Each accompanying text, with descriptions and recommendations, will be printed for a group of 150 such sheets that cover a total of about 150,000 acres.

Since Dr. Murkherjee studied with Dr. Agarwal and worked on his staff for sometime, he is following the same general system.

He emphasizes the importance of the salt water creeping in from the sea now that the Ganga has changed its course. Tidal water comes into the land through the many creeks of the old delta. Already some 77 square miles of arable land have been lost and the problem seems to get worse.

Somewhere north of Calcutta in a salty area the Dutch have a project as a gift to India for reclamation and for protection. I wish I could see it but that is impossible and my Indian guides seem to know little about it. Nor does Dr. Klemme.

I leave this State laboratory and go across the street to one financed by the Center. These people are mapping soil series at a scale of 1 inch equals 1 mile. They are doing at least part of their field work on sheets with a scale of 4 inches equal 1 mile that have been made by reducing the village maps from

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SOILS OF WEST BENGAL

by P. CHAKRAVARTI and MISS S. CHAKRAVARTI, *State Agricultural Research
Institute, Calcutta 40*

(Communicated by R. N. Chakravarti, F.N.I.)

(Received August 7; read December 6, 1957)

INTRODUCTION

In the state of West Bengal the major practice of cultivation is paddy and it is so intensively cultivated that it is hardly possible to demarcate the lands for rice grown and not rice grown as, out of the total area of about 12.3 million acres under cultivation, paddy occupies almost 10.0 million acres. Throughout the year the practice of paddy cultivation can be seen in some places or other as there are various varieties which can be grown well under different soil climatic conditions. Yet the main growing season of paddy is from June to December when the ideal climatic condition for paddy cultivation under waterlogged condition prevails all over the state. Though the annual average rainfall over the entire state exceeds 40 inches, the required minimum for growing paddy crops as stated by de Geus (1954), there remain to be investigated the factors that account for different performances like varietal, manurial and cultural practices of paddy at different places. Since these in turn depend mostly on the soil factor, a knowledge of different kinds of soils growing paddy is essential for proper formulation of agronomy, fertiliser practice, irrigation requirements and such others. We have been surveying these soils for the last four years and a system of classification of soils has been evolved as shown below (Table I).

The different types of soil occurring in West Bengal have been described and discussed in the following pages and a tentative map indicating their distribution has been given (Text-fig. 1). In the genetical classification of soils of the State the genetic method adopted by the Soil Survey Staff (1951), United States Department of Agriculture, has been followed.

LATERITE AND LATERITIC SOILS

These soils occur in the districts of Birbhum, Burdwan, Bankura and Midnapur. The land is undulating and has many tiny rivulets. These rivulets are dry except during rains. Soil erosion varies from slight to very high. At places the honeycomb structured laterite beds have been exposed. Surrounding these are terraced paddy fields, extending down to the bed of the rivulets. The paddy fields are yellowish grey on top and red below.

The soils are acidic (pH 5.5 to 6.5), poor in calcium, organic matter, available phosphate and in bases. The topsoils are poor in iron due to leaching and accumulation takes place in deep subsoils.

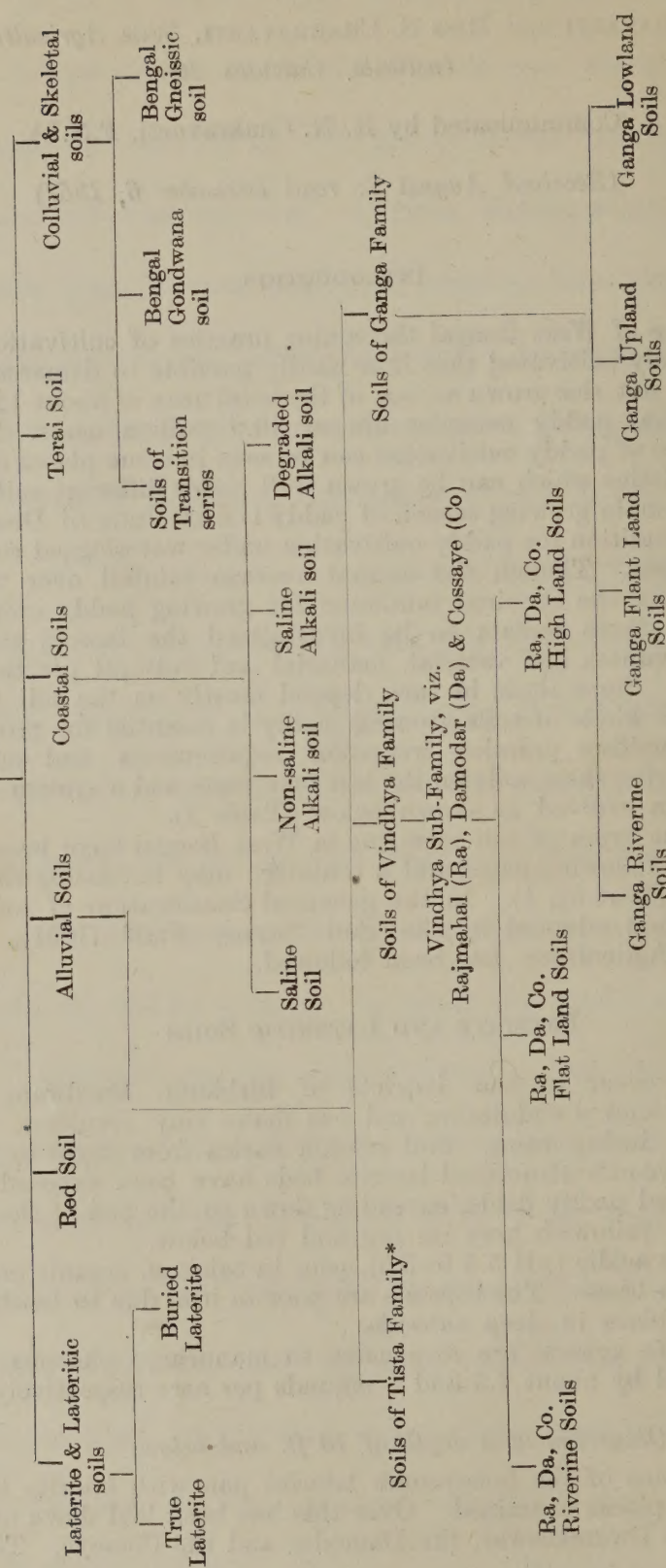
These soils in general are responsive to manuring; phosphate and nitrogen increase the yield by about 2.5 and 4 maunds per acre respectively.

Buried Laterite (Occurring at a depth of 10 ft. and below)

The occurrence of the honeycomb laterite pan with laterite below could be met with in the places examined. Over this has been laid down an alluvium, by the floods of the Dwarekeswar, the Damodar and the Cossaye. This might have

TABLE I

SOILS



* Study of different characteristics and their classification is under investigation.

occurred in prehistoric ages, when the adjoining coal bearing Gondwana tracts may have been formed due to violent geological disturbances. Over the laterite pan lies a layer of heavier soil with occasional dolomite in it. Here concretions do not occur in a layer, but are scattered in the profile from 8 ft. to 10 ft., varying in length from 2 to 5 inches. The concretions and the silty clay accumulation seem to be a riverborne deposit. Over these (the buried laterite and the dolomite ridden heavy soil), stands the present profile of Damodar flat land. The surface layer appears to be younger in formation. This tract occurs in the districts of Birbhum, Bankura, Burdwan and Midnapore. Increase in yield of paddy with nitrogen is not significant. When phosphate is added along with it high responses are obtained, indicating a typical phosphate deficient tract.

RED SOILS

These soils occur in the districts of Birbhum, Burdwan, Bankura, Midnapore, Malda and in West Dinajpore. The soils are coloured Red or Brown having variable thickness, with or without occasional lime concretions in the profile and morrum or feldspar below. Pisolithic concretions containing sesquioxide at places increase in great numbers. At some places these have become numerous and have formed laterite like blocks. At these places the surface vegetation peculiarly enough has also changed from Sal to Palas. When this happens the area gives chessboard appearance of Red soil, Lateritic soils and Laterites, and they occur in such a close proximity that it has been shown separately in the map as Lateritic Red soil group. These soils are mildly acidic (pH 6.0 to 6.6), poor in calcium, organic matter, available phosphate and bases. Iron is poor on the top and increases with depth. Paddy grown in these soils responds well to nitrogenous and phosphatic manuring.

ALLUVIAL SOILS

The soils of the alluvial tract can be divided into two families depending upon the nature of the parent material, i.e., alluvial deposits from which they have been derived. The coined names given to the families are :

Ganga Alluvium.—All these soils, which have originated from the Gangetic alluvium have been given the family name "Ganga alluvium".

Vindhya Alluvium.—The family name "Vindhya alluvium" has been coined for the soil association which has been formed from the alluvium brought down by the rivers, originating from Rajmahal hills and Chottanagpur plateau, a physiographic continuity of the Vindhya ranges.

VINDHYA FAMILY

Rajmahal, Damodar, Cossaye Riverine

These associations having different soil types are characterised by profiles, having layers, without a regular sequence, immature, irregular layeration, with occasional bands of sand. Sands are coarse and are yellowish brown in colour. These soil associations occur in the districts of Murshidabad, Birbhum, Bankura, Burdwan, Hooghly and Midnapore.

The positions of these associations have been indicated in the accompanying map. These associations have an innundated sandy phase, which gets periodically submerged. These soils respond well to nitrogen but give poor response to phosphate except in one or two soil types in these regions. These soils are mostly neutral (pH 6.5 to 7.2) and have an average lime and base status.

Rajmahal, Damodar, Cossaye Flat Lands

These soil associations occupy almost a flat topography, away from the influence of floods from which the Vindhya Riverine lands suffer. Due to incomplete weathering the distinct soil horizons could not be formed. Yet in the soil profiles layers can be distinguishable, to some extent by their colour, moisture contents, root penetration, texture and other physical characteristics.

There is very slight illuviation of sesquioxides in the lower layers. Calcium, potassium and clay indicate that a process of weathering and leaching has started, as a result of which pH tends to become slightly acidic. There are occasional dolomite concretions of fairly big sizes occurring at random in the profile. The mode of distribution of these concretions indicate that these are flood borne deposits and have not been formed *in situ*. Brown iron concretions of irregular size occur in lower layers which do not effervesce with hydrogen peroxide indicating absence of manganese in them.

These soil associations occur in the districts of Murshidabad, Birbhum, Bankura, Burdwan, Hooghly and Midnapore. Their locations have been shown in the accompanying map.

These soils are mildly acidic (pH 5.8 to 6.8); calcium, iron and other bases are low on top and increase with depth. They respond well to the application of nitrogen, whereas phosphate gives response only in the clay types where addition of nitrogen does not give increased paddy yield.

Rajmahal, Damodar, Cossaye Highlands

These soil associations occur in the districts of Murshidabad, Birbhum, Burdwan Hooghly, Bankura and Midnapore. Their positions are indicated in the accompanying map. These are associations of different soil types, having mature profiles. Leaching of clay, sesquioxides, alkaline earths and alkali metals and their accumulation in the lower horizon are evident. Mottlings are present. Dolomite concretions occur, often in thick layers. These soils are mildly acidic, pH. 5.8 to 6.9, which increases with depth. Calcium and other bases are low on top but increase in the subsoils. Phosphate content is low. Leaching of iron from top soil and accumulation in subsoil have taken place.

Response to nitrogen is low and to phosphate lower still. The yield of paddy can hardly be increased by 3 mds. per acre by application of nitrogen.

GANGA FAMILY OF SOILS

Ganga Riverine

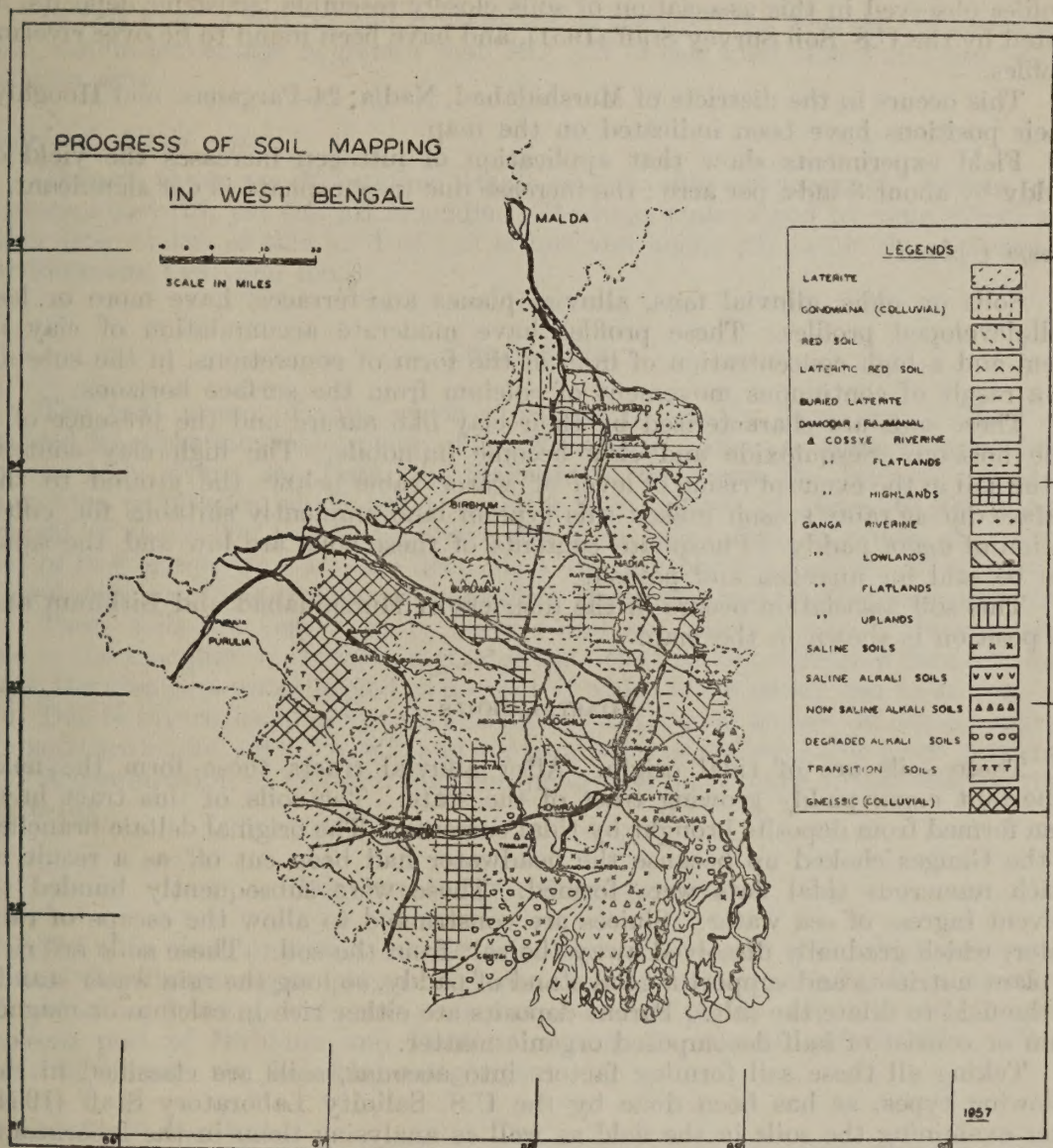
This kind of soil is found in the districts of Murshidabad, Malda, 24-Parganas, Burdwan and Hooghly and has been indicated on the map. This association of soils has an immature profile. Chemical and morphological observations show that one or two sandy layers are often found in the profiles examined. Sand fractions consist mostly of finer fractions, grey or greyish white in colour, having occasionally small plates of mica which shine in reflected light. These soils are rich in calcium. Free calcium carbonate occurs over most of the area either in the surface soils or within 2 to 3 ft. in the profile. The yield of paddy grain in this tract can hardly be increased by over 3 mds. per acre by application of nitrogen. Addition of phosphate does not give economical response.

Ganga Flat Land

This soil association occurs in the districts of Murshidabad, Nadia, 24-Parganas, Burdwan and Hooghly. It has a slightly more mature profile than the riverine soil. Slight illuviation of clay to the lower layer has taken place. Sesquioxides,

alkaline earths and metals all indicate slight leaching from the top and accumulation at the bottom. At places the subsoils still contain free calcium carbonate. The sand fraction is predominantly finer in size and whitish grey in colour.

No significant response in yield of paddy with phosphate fertilisers is found, whereas the increased yield of paddy with nitrogenous fertilisers is about 3 mds. per acre.



TEXT-FIG. 1.

Ganga Low Land

This association of soils occurs in places where depressions have been created due to the meandering of different rivers. The abandoned river courses and depressions, caused by strong diluviation by river currents, receive the washings from the surrounding flat or riverine lands. The Ganges also deposits a large amount of silt and clay in its diurnal tidal flows and ebbs. These factors have

been responsible for gradual filling up of river beds and marshes found in different localities. During rains these appear like lakes, where reeds mostly grow. Cultivation of *aman* paddy is carried out in the shallower places and of *boro* in the deeper ones.

This association is characterised by a profile having clay in the top horizon, followed by subsoils which are often very light, even consisting of riverborne loess or coarse sand. At places calcium carbonate concretions are met with. The profiles observed in this association of soils closely resemble lacustrine deposits, as stated by the U.S. Soil Survey Staff (1951), and have been found to lie over riverine profiles.

This occurs in the districts of Murshidabad, Nadia, 24-Parganas, and Hooghly. Their positions have been indicated on the map.

Field experiments show that application of nitrogen increases the yield of paddy by about 3 mds. per acre ; the increase due to phosphate is not significant.

Ganga Upland

Soils on older alluvial fans, alluvial planes and terraces, have more or less well-developed profiles. These profiles have moderate accumulation of clay in them and a high concentration of lime in the form of concretions, in the subsoil, as a result of continuous movement of calcium from the surface horizons.

These soils are characterised by their clay like nature and the presence of a lime horizon. Sesquioxide and clay become immobile. The high clay content of the soil in the event of rising of level of water table below the ground to the surface during rainy season makes this type of land eminently suitable for cultivation of *aman* paddy. Phosphate contents of these soils are low and the same can be said for nitrogen and potash.

This soil association occurs in the districts of Murshidabad and Birbhum and its position is shown in the map.

COASTAL SOILS

These soils are of tidal origin. After alluvial tracts these form the next important *aman* paddy growing tract of the state. The soils of this tract have been formed from deposits brought by tidal currents. The original deltaic branches of the Ganges choked up because the headwater had been cut off, as a result of which numerous tidal flats were formed. These were subsequently bunded to prevent ingress of sea water. Sluices are constructed to allow the escape of rain water, which gradually dissolved away the salt from the soil. These soils are rich in plant nutrients and support a good stand of paddy, so long the rain water stands in the field to dilute the salt. Parent deposits are either rich in calcium or magnesium or consist of half decomposed organic matter.

Taking all these soil forming factors into account, soils are classified in the following types, as has been done by the U.S. Salinity Laboratory Staff (1954) after examining the soils in the field as well as analysing them in the laboratory:

- (i) *Saline soils*, (ii) *Non-saline alkali soils*, (iii) *Saline alkali soils*, (iv) *Degraded alkali soils*.

These soils are met with in the districts of 24-Parganas, Midnapore and Howrah. Positions of these soil associations are shown in the accompanying map.

Saline soils

Soils with salt content greater than 0.15% and exchangeable sodium percentage less than 15, are grouped under this head. The pH of this kind of soil varies between neutral to slightly alkaline.

Saline Alkali soils

Soils with salt content greater than 0.15% and exchangeable sodium percentage more than 15, are grouped under this soil association. *pH* of this type of soil generally reads over 7.5 and the soil particles remain flocculated in a soil water mixture.

Non-saline Alkali soils

In this kind of soil the salt content is less than 0.15%, whereas the exchangeable sodium-percentage is greater than 15. *pH* of this kind of soil also lies on the alkaline side.

Degraded Alkali soils

Though these are Non-saline Alkali soils having exchangeable sodium percentage above 15, yet the *pH* is acidic. The lime content and to some extent the other base status of this kind of soil is low and acidic *pH* is for the presence of predominant hydrogen ion.

TERAI SOILS

The next group of soils which grow paddy are the Terai soils. They are derived from the mountain region of the Himalayas. These soils are brought down by the hilly rivers, the Tista, the Mahananda, the Torsa, the Jaldaka and their numerous tributaries which bring material from heights of above 10,000 ft. and deposit it about 200 to 300 ft. above sea level. The deposits are mostly sandy and of raw humus type and are deep black to grey black in colour. They occupy a good amount of paddy areas of Jalpaiguri, Darjeeling and Cooch-Bihar districts.

These soils are very light in texture and are highly porous. During rains, due to the precipitation becoming greater than the rate of infiltration through these soils, the area gets water-logged as a result of which *aman* paddy can be grown.

Due to severe leaching by rain and presence of a good amount of organic matter the soils are acidic, *pH* 4.7 to 5.8, and are poor in bases and available plant nutrients.

A combination of nitrogen and phosphate has been found to increase the yield of paddy.

COLLUVIALS AND SKELETAL SOILS

The soils next in area are colluvials derived from the hills which are extension of the Chottanagpur plateau. These skeletal soils, containing large amounts of coarse sand and gravel grow poor and uncertain paddy crop and occur in the western part of Birbhum and Bankura and in the Asansol sub-division. These are divided into the following categories :

Bengal Gondwana Soils

These soils are derived from the parent rocks which have been formed during the Gondwana period.

Bengal Gneissic Soils

The soils that are formed from the parent Gneissic rocks.

Transition Soils

Parent rocks from which these soils are formed are of Sub-metamorphic type similar to those of Bijawar and Gwalior series.

TABLE II
Approximate Chemical Composition of the Soils (Constituents as per cent of air-dry soils)

Soils	pH	CaO	K ₂ O	P ₂ O ₅	Carbon	Nitrogen
<i>Laterite & Lateritic soils</i>						
	5.5—6.5	0.1—0.4	0.1—0.4	0.01—0.05	0.05—0.5	0.01—0.08
<i>Red Soils</i>	6.0—6.6	0.1—0.5	0.1—0.8	0.01—0.05	0.05—0.5	0.01—0.05
<i>Ganga Family:</i>						
(a) Ganga-Riverine soils	7.5—8.2	1.0—5.0	0.3—0.7	0.10—0.15	0.20—0.3	0.02—0.05
(b) Ganga Flat land soils	7.0—8.0	1.0—6.5	0.4—1.0	0.10—0.15	0.30—0.5	0.04—0.06
(c) Ganga-Upland soils	6.0—7.5	0.5—2.0	0.1—0.4	0.03—0.06	0.30—0.5	0.03—0.06
(d) Ganga-Lowland soils	7.0—8.2	0.6—3.0	0.1—0.4	0.06—0.1	0.50—1.0	0.05—0.09
<i>Vindhya Family:</i>						
(a) Vindhya-Riverine soils	6.5—7.2	0.3—0.6	0.1—0.45	0.025—0.04	0.05—0.15	0.005—0.02
(b) Vindhya-Flat land soils	5.8—6.8	0.4—0.7	0.1—0.2	0.01—0.05	0.10—0.4	0.02—0.05
(c) Vindhya-High land soils	5.8—6.9	0.3—0.6	0.4—0.5	0.02—0.05	0.20—0.5	0.03—0.06
<i>Coastal soils:</i>						
(a) Non-Saline alkali soils	7.2—8.3	0.45—0.8	0.5—1.5	0.10—0.2	0.20—0.6	0.04—0.08
(b) Saline soils	6.5—7.6	0.6—0.8	0.3—1.0	0.06—0.1	0.30—0.8	0.05—0.1
(c) Degraded alkali soils	5.0—7.0	0.4—0.5	0.4—0.8	0.07—0.15	0.50—2.0	0.05—2.0
(d) Saline alkali soils	7.5—9.0	0.4—0.8	0.5—1.0	0.10—0.15	0.20—0.6	0.04—0.07
<i>Terai soils</i>	4.7—5.8	0.1—0.2	0.1—2.0	0.10—0.2	0.80—3.0	0.09—0.2
<i>Colluvial & Skeletal Soils:</i>						
(a) Gneissic	5.5—7.5	0.25—2.0	0.2—1.3	0.02—0.2	0.15—0.7	0.02—0.11
(b) Gondwana	6.0—7.0	0.10—0.50	0.2—0.6	0.02—0.06	0.30—0.8	0.03—0.08
(c) Transition	5.5—7.0	0.08—0.65	0.3—0.7	0.03—0.07	0.20—0.6	0.02—0.08

The areas where these types of soils occur have undulating topography. The paddy fields are terraced among the black coloured boulders of giant size or rock surfaces or hills or eroded lands. The land on the top of the undulated topography is often left without cultivation, due to the difficulty of holding rain water in those places. Those lands, when allowed to remain as such for long periods, turn gradually into Sal or Palas jungles.

ANALYTICAL RESULTS

The chemical constituents that are required for the growth of paddy have been estimated in the above mentioned different types of soils following the method of analysis given by de Sigmond (1938), Williams (1928) and Wright (1939). The figures are shown in Table II.

ACKNOWLEDGEMENTS

Thanks are due to the staff of Soil Survey Project, West Bengal, Shri D. Roy, Shri P. Roy, Shri P. Gupta, Shri A. Neogi, Shri S. Bhattasali and Miss B. Roy for their inestimable help during the progress of this work and to Dr. S. K. Mukerji, Agricultural Chemist, West Bengal, for his kind guidance. The authors are also indebted to Shri Sisir Kumar Ghose, for his earnest help in taking soil monoliths from different places.

SUMMARY

The soils of the State of West Bengal have been classified under different categories and their characteristics have been studied. The distribution of each kind of soil has been shown in an accompanying map. A brief description of each of these soils is given. Chemical constituents of these soils are also given.

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Issued December 26, 1957

INSTRUCTIONS FOR FIELD OBSERVATION

This will be a sort of reconnaissance survey. The field observation will consist of the following:-

1. Topography and surface feature (a) Nature of the surface-Flat, Rolling, broken, ~~and~~ transition from one stage to other direction and steepness of the slope. (b) Presence of Kandors, cannals, rivers-their nature, breadth-perennial or seasonal- their water supplying power. Possibility of tapping that source for irrigation (i) Winter crop. (ii) Kharif crop- Approx. area that can be served. (c) Natural vegetation- their condition. (d) Field crops. single cropped or double cropped, approx. yield of different crops, irrigated or not - system of irrigation, sources of water supply, manures and their response.

2. Field study of the soil. The colour and nature of the soil, Information regarding sub-soil; presence or absence of bed rock; if present approx. depth of the ~~surface~~ soil. Presence or absence of morrum and concretions, The texture (such as sandy loam, clay loam, silt loam, clay etc.).

Water conditions:

Subsoil water- its depth below the surface
(a) during rainy season,
(b) during dry season

Waste lands:

Their nature and extent, Possibility of reclamation.

The party when they will go out for survey work will avoid permanent ways as far as practicable. In course of their survey whenever they come across a soil which appear to be different either in colour, texture or any other characteristics, they should immediately proceed with the study as detailed above.

Much of the informations may be collected from the local people. The informations collected by local enquiries will simply serve as a guide and should never be accepted as automatic truth. These informations will in many cases serve in closing the boundaries of the different types of soil that may occur in a particular area.

In this particular kind of survey the sampling distance should generally be 2-5 miles according to topography of the area.

Informations about the sub-soil water may be collected from the neighbouring wells.

In cases of doubt, deep pits may be dug to ascertain the presence for absence of bed rock.

A detailed information about the waste lands should be collected - whether the fallowing is due to the impence of drainage or due to the lack of provision for water supply or any other cause. If it is due to the former cause what are the possible means of reclamation i.e. how the drainage can be improved, if due to the later cause what is the source of water supply.

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In this particular kind of survey the sampling distance should generally be 2-3 miles *randomly selected*. Information about the sub-soil water may be collected from the neighbouring wells.

In cases of doubt, deep pits may be dug to ascertain the presence or absence of bed rock.

A detailed information about the waste lands should be collected whether the following is due to the impedance of drainage or due to the lack of provision for water supply or any other cause. If it is due to the former cause what are the possible means of reclamation i.e. how the drainage can be improved, if due to the latter cause what is the source of water supply.

Pit No. _____

Date of collection _____

Collected by _____

Province _____ Relief _____ Drainage _____

District _____ Elevation _____ Moisture _____

P.S. _____ Slope _____ Ground water _____

Mouza _____ Erosion _____

J.L.No. _____ Parent material _____ Salt & alkali _____

Map ref: _____ Vegetation _____ Any deposit _____

Field sample No.

Horizon

Depth

Thickness

Boundary

Colour

Colour of mottling

Moisture

Structure

Texture

Consistence

Concretion

Root-distribution

Reaction

Carbonate

Special feature

Permeability

Remark

Crop & varieties :

Fertilizers & manures
used if any & response:

Irrigation, if any:

Yield:

INFORMATION SHEET

1. Name of Agricultural Inspector/Extension Officer

2. Name of District:

Thana

3. Profile No.

Date of collection:

4. Locality i.e. Village :

Union : Mouza:

Thana / J.L. No.

Owner of the Field:

Plot No.:

5. A copy of the P.S. map indicating jurisdiction of each A.I. & the location of the pits in reference to that map. He may indicate Union boundaries and location of item 11 & 12 P.S. wise, using different legends in every case.

6. Natural vegetation:

7. Layer :

Depth in inches	Degree of moisture.	Root Penetration,	Insect holes.	Texture (Local name*).	Concre-tions. **	Colour of the soils ***	Hardness of soil	pH	Effer-vescence with Hcl.
a)									
b)									
c)									
d)									
e)									

Sand, Sandy loam, Loamy sand, Loam, Silty loam, Clay loam, Silty clay, Silty clay loam, Sandy clay, and Clay, and Silt.

*Bele, Bele doash, Daush bele, Daush, Pali doash, Aintel doash, Matel, Metel doash Bele aitel, Aitel & Pali

**Black like Mustard, Mator or Bigger size, Shape regular or irregular, colour: White, Yellowish white, Deep red, Black, Greyish white, etc.

***Black, Deep black, Light black, Grey, Ashy grey, Yellow, Deep yellow, Light yellow, Red, Light or Deep Red, Orange, Purple, Whitish, Olive, Brown etc.

8. Relief (plain, rolling, basin shaped, undulating & inverted basinshaped) of
(1) Union: (2) The mauza where profile is taken:
(3) Actual site:

9. Agricultural practice of the area (Union)

(a) Crop rotation

(b) Fertilizers used & local opinion about them

(c) Irrigated - (1) Canal

(2) Tube Well

== (3) Tank

(4) Well

(5) Bund

(d) Un-irrigated (Average rainfall of last ten years)

10. Average yield of each crop grown in that Mauza:

11. A brief note of the area & location in the map: (i) Mauza (ii) P.S. H.Q.

(a) Aus area (b) Aman area (c) Area under water (d) Area of rabi in double cropping
(e) Area under forest. (f) Eroded area.

12. A short and clear note on the different kinds of soil occurring in your locality. Peculiarities are to be described and the area shown on your Police Station map.

13. Depth of water level : (From wells) (1) in summer :
(2) in rains :

[illegible]

100

16 inches equal 1 mile. Each project area is designed to include "one police station," which is about 100 to 150 square miles.

I have already discovered that the data they showed me in the field on mechanical analyses seemed to indicate a very low clay content. One glance of the laboratory explains this. They collect samples of this laterite material in bags and then use the hydrometer method!! Of course many of the particles harden irreversibly and the whole work is practically useless.

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Dr. Raychaudhuri, Mr. Digar, and Dr. Murkherjee all tell me about the fine cooperation between the staffs of the State and the Center. If they had told me this only once I might have believed it. "But the lady doth protect too much methinks." Actually, there is essentially no cooperation. I see little use for either the Extension program or the soil conservation program of these 1-inch-to-the-mile surveys made by the Center. Nor am I impressed much with the classification used by the State staff.

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I have dinner about 11:00. Dr. Khandekar is unfortunately handicapped here by his lack of experience with laterite soils, saline soils, or tropical crops. About 9 o'clock my driver returns me to my hotel.

January 20: I check out of the hotel and leave at 7:30 for the



With combined staff of the Center's Soil Correlation Laboratory (laterite soils) and of the State Chemist. January 19, 1958. (S.P.R.)

Dr. Khandekar and his secretary, S. K. Soud, and I leave on the plane at 9:15 a.m. The combination of heat and a bad cold in the plane makes it very difficult for us to see the ground. But about 150 miles I see many mature rice plants growing in the paddy fields. The paddy land looks brown and dry. I see almost no winter crops, although there appears to be water in the streams and in the ponds.

I have dinner chez Klemme. Dr. Klemme is exceedingly handicapped here by his lack of experience with lateritic soils, saline soils, or tropical crops. About 9 o'clock my driver returns me to my hotel.

January 20: I check out of the hotel and leave at 7:30 for the airport. No shops are open. There are still many poor people sleeping on the sidewalks along with the cows.

At the airport I meet Mr. S. Sarkar, Regional Officer of the Government of India in Calcutta. He believes that crop yields can be greatly increased with more irrigation water from the ordinary wells and tube wells. He says that the groundwater is adequate. He tells me that the cultivators must form cooperatives and these should have long-term loans from the government. He emphasizes the need to continue the fertilizer demonstration scheme. I am told that this man is probably coming for study in the United States, and first to the University of Missouri! (I don't know what he will learn about lateritic soils, saline soils, and tropical crops at Missouri.)

Dr. Raychaudhuri and his secretary, S. K. Sood, and I leave on the plane at 9:16 a.m. The combination of haze and a bad seat in the plane makes it very difficult for me to see the ground. Out about 150 miles I see many mature streams meandering to the sea. The paddy land looks brown and dry. I see almost no winter crops, although there appears to be water in the streams and in the ponds.

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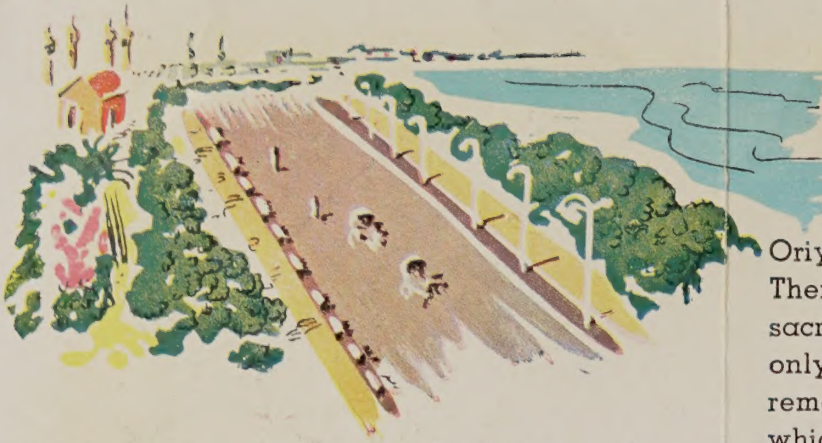
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Calcutta -
Madras -
Bangalore



Routes of the Go

AT the cross-roads of air traffic between the Far East and the rest of Asia and Europe, a major sea port and railway terminal, a commercial and manufacturing centre, Calcutta contains many worlds. In one area you will feel you are in the Middle East, in some small Arab Town, in another you are in China, or in London (there are night-clubs with a real West End touch). If you stay a whole season in Calcutta, you will see each world coming out in its own costume—a Muslim wedding procession, a colourful Hindu Festival, a Chinese New Year celebration.

In and around Calcutta are many sights for the student of both ancient and modern history. At the edge of the vast open vista known as the Maidan there is Fort William, a fine underground fort which can accommodate 10,000 men, the Howrah bridge, third largest cantilever bridge in the world; the Jain Temple at the eastern end of the city, with its altar set with Diamonds, rubies and other precious stones; the Kalighat Temple built in 1809 to Kali, destroyer of evil, patron goddess of many devout Hindus; and the magnificent Hindu Monastery of Belur Math headquarters of the Ramakrishna Mission—which viewed from different angles represents a church, a mosque and temple.

From Calcutta you fly south into the State of Orissa, reaching after an hour and forty minutes Bhubaneswar, "the metropolies of temples". This city is one of many sites which is profuse with the evidence of a vigorous

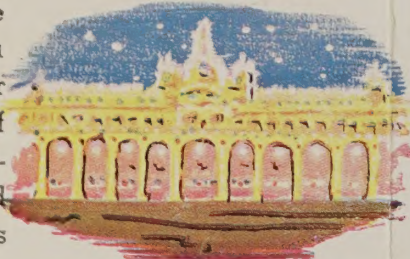
Oriya culture which goes back to 300 B.C. There were once 7,000 temples around the sacred lake of Bhubaneswar. Now there are only 500, mostly in ruins. Yet enough evidence remains of the great genius of Hindu sculpture which tells its fantastic story in gigantic stone carvings and delicate miniature sculptures and statuettes. The great Lingaraj towering 180

feet above its stone platform encompasses 64 secondary temples. It is "the finest example of a purely Hindu temple" and draws an endless traffic of pilgrims and tourists. You can walk half a mile north-east to Kedar-Gauri where you will see people at the popular



sacred well whose waters are specially curative for intestinal ailments. The Mukteswar Temple is close by with some of the finest example of Oriyan sculpture—and so is the Raja-Rani and Parasurameshwara temples. Further afield is the celebrated black Pagoda of Konarak with its lifelike dancers, battling lions and scenes full of elaborate action—exquisite examples of Oriya sculpture at its zenith.

Your next stop south is



CALCUTTA - MADRAS -

We are down for a little while at Bhubaneswar. From nearby diggings the soil appears to be a Red Latosol thin over the country rock that appears to be old sandstone or conglomerate. I see no deep laterite crust but I strongly suspect that it must be in this general area. At the airport they have 76 inches of rainfall. Some of this could be impounded for irrigation of winter crops but only a few fields are irrigated.

Between 11:03 and 12:35 we fly to Visakhapatnam. The sky is so hazy I can see very little. To the west there are mountains and toward the sea to the east the land is nearly flat or gently undulating to rolling. The soils with easy slopes are used mainly for paddy but there is a little irrigated pasture and winter cereal. We have a long wait here because the plane from Madras is late and at this station the crews change planes. It is sunny and quite warm but hazy. I am amazed to see the method of hauling gasoline to the plane. They have a new small bright red tank wagon pulled by bullocks. We finally leave at 1:51 p.m.

The hills along the coast resemble "haystack hills." But it is cloudy nearly all the way to Madras. This city appears to be on a nearly level plain near the sea except for a few scattered red hills. The streams crossing from the bold hills to the west seem full of water. I see quite a few green fields with winter crops.

We are down about 4 o'clock and go by bus to the city. Here the soil is not quite so dry as in the other cities I have seen.

Route of the

We are down for a little while at Bhudhawan. From near

digging the soil appears to be a Red laterite thin over the

C. B. 300 of hard soil which is not very good for

country rocks that appear to be old sandstone or conglomerate.

There are no deep laterite pits but strongly suspect that it may

be in this general area. At the airport they have 70 inches of

rainfall. Some of this could be impounded for irrigation of

winter crops but only a few fields are irrigated.

Between 11:03 and 12:35 we fly to Vishakhapatnam. The sky

is very hazy I can see very little. To the west there are mountains

and toward the sea to the east the land is nearly flat or gently

undulating to rolling. The soils with easy slopes are used for

For paddy but there is a little irrigated pasture and winter crops

We have a long wait here because the plane from Madras is late.

It is sunny and quite warm but hazy. I am amazed to see the method of hauling gasoline

to the plane. They have a new small bright red tank wagon pulled

by bullocks. We finally leave at 1:51 p.m.

The hills along the coast resemble "hazy hills." But it

is cloudy nearly all the way to Madras. This city appears to be

on a nearly level plain near the sea except for a few scattered

red hills. The streams crossing from the bold hills to the west

seem full of water. I see quite a few green fields with winter

crops.

We are down about 4 o'clock and go by bus to the city. Here

the soil is not quite so dry as in the other cities I have seen.

The grass is a bit greener. The soils are probably Red or Reddish-Brown Latosols from old alluvial terraces. I see no laterite.

I feel a bit sorry for many workers digging trenches in this hot sun. From the air station I take a taxi to the Oceanic Hotel.

This seems to be a nice looking city and in great contrast to Calcutta. There are many wide streets, nice buildings, and fine gardens. In just a few minutes several gentlemen call on me and we have tea:

Mr. A. Muhahmad Ali, Joint Director of Agriculture, Madras

Mr. T. Rajagopalaiyengar, State Compost Development Officer

Mr. S. E. Anantaraman, Assistant Agricultural Engineer

I am told that the rainfall in Madras is about 40 inches.

There is some winter rain (two monsoons, June to August, and September 15 to January 1). I am told that the hills to the west are mainly granite.

It is said that cultivators here use much green manure including some legumes grown outside the paddy fields. In addition they use ammonium sulphate, urea, and superphosphate. They tell me that yields are about 14 maunds (1250 pounds) per acre, in contrast to the Indian average of 7 maunds per acre. Paddy land is held at 2500 rupees per acre and the net return from paddy is said to be 500 rupees per acre. The average cultivator

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SOIL CONSERVATION WORK IN MADRAS STATE.

The problem of soil conservation is one of countrywide importance and not merely State concerned. Its nature and intensity was becoming more complicated and increasing year by year as it involves the conservation of moisture at the same time. Therefore a co-ordinated and sustained effort on a countrywide scale became urgently necessary to combat the same successfully. The importance of soil conservation has been recognised by the framers of the Five Year Plan and they have detailed the steps to be taken to check the menace. The measures for controlling soil erosion and restoring the productivity of eroded lands had been classified by them into four groups namely ⁽¹⁾ the regulation of land use, ⁽²⁾ afforestation and preservation of forests by scientific forest management, ⁽³⁾ the improvement of land utilisation and practices on farm lands and the engineering ⁽⁴⁾ measures. The relative importance of the different measures could vary greatly in different areas depending upon the particular conditions obtaining in the several regions.

2. On the recommendation of the Planning Commission and in accordance with the suggestion of the conference of the State Ministers for Agriculture and Co-operation held at New Delhi, a Central Soil Conservation Board was constituted and certain functions had also been specifically assigned to this Central Board. The chief object of the Board was to generally render technical advice and help on conservation of soil, protection of lands, reservoirs and projects against the erosion menace all leading to the promotion of better agriculture.

3. So far as this State is concerned, although the problem of soil erosion had focussed the attention of this

The problem of soil conservation is one of country importance and not merely State concerned. Its nature and intensity was becoming more complicated and increasing year by year as it involves the conservation of moisture at the same time. Therefore a co-ordinated and sustained effort on a countrywide scale became urgently necessary to combat the same successfully. The importance of soil conservation has been recognised by the framers of the Five Year Plan and they have detailed the steps to be taken to check the menace. The measures for controlling erosion and restoring the productivity of eroded lands have been classified by them into four groups namely the (1) reforestation of land use, afforestation and preservation of forest by scientific forest management, the improvement of land utilisation and practices on farm lands and the engineering measures. The relative importance of the different measures could vary greatly in different areas depending upon the particular conditions obtaining in the several regions.

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Government, it was only recently practical steps had been taken on a planned basis to effectively tackle this problem. The Madras Land Improvement Schemes (Contour Bunding and Contour Trenching) Act was passed in 1949. The Government had also constituted the District Soil Conservation Board in 1948 for the Nilgiris district, where soil erosion ravages had been particularly severe due to the indiscriminate clearing of the hill slopes for the cultivation of Potato, the principal commercial crop. A Soil Conservation Board on a State level was set up to plan initiate, co-ordinate and control soil conservation and land utilisation works in the State.

4. The following soil conservation schemes were undertaken by this Department during the first and second five year plan periods.

1. Ketty Valley Pilot Scheme to tackle 88.65 acres.
2. Ketty Valley Extension Scheme in the Nilgiris district to tackle 203.35 acres.
3. Bench terracing work undertaken in the Agricultural Research Station, Nanjanad in an area of 80 acres.
4. Kammandhu Village Scheme in the Nilgiris district to tackle 201.41 acres.
5. Nilgiris District Special Comprehensive Scheme to tackle 5,000 acres.
6. Mulanur Scheme in the Coimbatore district to tackle 6,000 acres.
7. Kangayam - Vellakoil Scheme in the Coimbatore district to tackle 6,000 acres.
8. Avanashi Coimbatore Scheme to tackle 5,500 acres.
9. Kothamangalam Fuel Series Scheme in Coimbatore district to tackle 4,046 acres.
10. Palladam Scheme to tackle 2,500 acres.
11. Vadachittoor Kondampatte Scheme in the Coimbatore district to tackle 3,000 acres.
12. Kannivady Scheme in the Coimbatore district to tackle 5,000 acres.

13. Kolarpatty Firka Scheme in the Coimbatore district to tackle 2,000 acres.
14. Tiruchirapalli District Scheme to tackle 960 acres.
15. Kodaikanal Scheme to tackle 250 acres.
16. Vellore Wallajah Scheme in the North Arcot district to tackle 6,000 acres.
17. Kadambuliur Scheme in South Arcot district to tackle 6,000 acres.

5) As per orders of Government training has been imparted to the Revenue Inspectors, Village Officers, Gramasevaks, Block Development Officers and Assistant Project Executive Officers in the Coimbatore district in simple methods of soil conservation. The Government have also sanctioned a scheme to impart training to 100 ryots in the Nilgiris district in simple methods of soil conservation. The above scheme was completed on 31-3-57.

6) The following Officers have undergone one year training in soil conservation at the Government of India Training Centre, Dehra Dun.

1. Sri C.R. Shanmugham, Assistant Agricultural Engineer, Soil Conservation Scheme, Ooty.
2. Sri S.E. Anantharaman, Assistant Agricultural Engineer M.B.Shed, Saidapet.
3. Sri T.S. Palanivelu, Agricultural Engineer, Madras.

The following Assistant Agricultural Engineers have also been deputed to undergo one year training course in soil conservation at the Government of India Training Centre, Dehra Dun, and they will be completing their training course on 31-5-58.

1. Sri C.S. Sridharan
2. Sri K. Natarajan

at the Government of India Training Centres, Ooty and Bellary

has about 2 acres of total land with one-half of it devoted to paddy. A good deal of sugarcane is grown. Some of the cultivators have paddy and sugarcane in rotation. When I am told that they have a large number of irrigation projects in this State, including some new ones, but not much work on the important problem of consolidation of scattered holdings. They also have some new land development projects to make arable acres from scrubby forests and some from the coastal saline soils.

As yet there is no scheme for soil surveys but some soil testing is done on samples to give cultivators fertilizer recommendations. The soil conservation work here seems to be mainly contour terraces on the hill slopes and contour bunding in the low areas. The Joint Director tries to tell me that all he needs is money and materials to go ahead with soil survey and soil conservation work. He is unconvincing. It is very difficult for me to understand where he will find the skilled people.

(Added later: I discover that the State of Madras has just recently acquired some land with good conservation work on it that was shifted from Bombay State during the recent reorganization of the State boundaries. Perhaps this work will stimulate Madras to go ahead and do likewise elsewhere. Certainly these men don't understand the skill required).

My guests leave and I go for an early dinner at 7:30 and then to bed.

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then to bed.

January 21: I am up at 4:30 to dress and pack for the early plane. I am able to have only a light breakfast.

As I wait for the taxi it is warm, still, and pitch dark. When the taxi comes with Dr. Raychaudhuri and Mr. Sood I have to give the driver an advanced payment so he can buy enough gas to get us to the airport. My Indian companions are exceedingly slow in getting out their purses. So I pay. But their allowances are very low. Daylight comes while we wait for the plane.

We leave at 6:50 for Bangalore. The ponds, canals, and streams seem to be full of water. Many fields have been flooded for irrigation but only a few of them have winter crops.

As we approach the mountains, locally called the Eastern Ghats, the fields are greener, mainly with sugarcane. Nearly half way to Bangalore the landscape is a pattern of low, steep-sided granitic mountains, and small plains. We fly over a river of sand with channels dug into it apparently to tap underground water.

I see some fruit crops and some fields of small grain. As we go on the percentage of good soil decreases in relation to eroded red soils and especially Lithosols. Many fields above the canals appear to be severely eroded red soil of apparently little use, but the lower parts near the main villages have much sugarcane, which is probably the most profitable crop for the cultivators.

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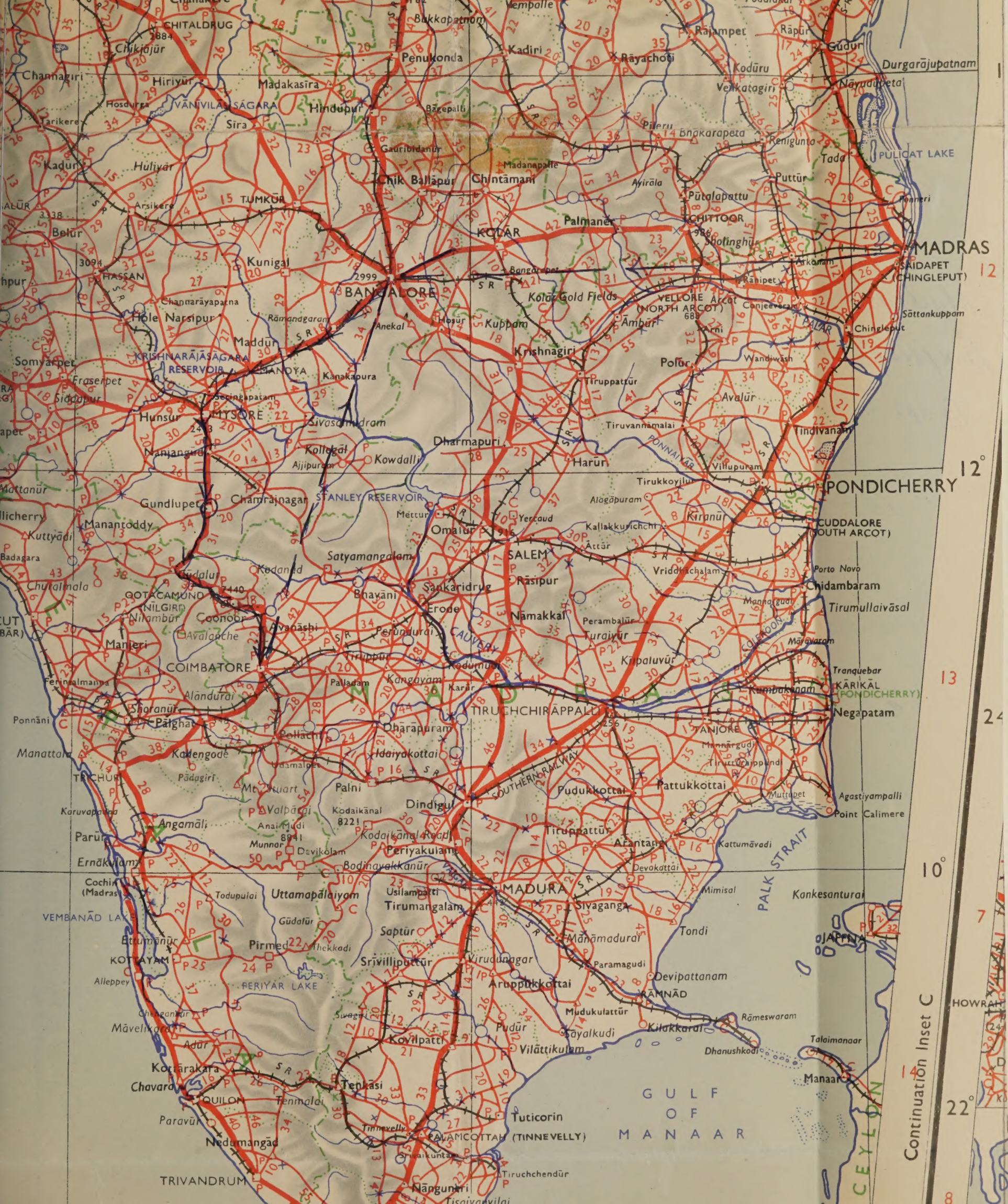
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100
Madras-
Bangalore
Trip

Then we pass over strong rolling scrubby woodland. Apparently the soils are latosolic Lithosols on granite. We pass over an undulating to rolling plain of red soil, much of which is severely eroded. Obviously many of the knobs should never have been cleared. I see good green fields only near the streams, where there are small dams for irrigation. Severe sheet erosion with some gullying is common on all the sloping uplands. Much of this cannot be expected to be reclaimed for cultivation. Of course, the severe erosion of the lithosolic knobs is inevitable under any kind of cultivation.

We pass over Kolar where there are said to be gold fields. As we fly on the percentage of lithosolic and eroded soil decreases. Most fields are bare. Dr. Raychaudhuri says there are outcrops of laterite here, but I see none, although I do see outcrops of the country rock (probably granitic gneiss) even on very gently slopes.

We are down at Bangalore at 7:33 and are met by several people here including Dr. E. J. Long, of Tennessee, in charge of the ICA college team here, Dr. R. L. Donahue, located at Hyderabad, and Dr. G. R. Muhr and Dr. G. W. Olsen, located at Nagpur. We are also met by the soil correlator for the red soils, Mr. Govindanrajan, Mr. Nadjandappa, office assistant to the Director of Agriculture, and Mr. S. S. Sirur, State agricultural chemist at Bangalore.

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The elevation here is 3,000 feet and the rainfall is about 25 to 30 inches. Most of the rain comes during the July monsoon and the October monsoon. The other months are dry. On the way from the airport to the hotel I am told that they get two paddy crops per year under irrigation in favored places. Their dry-land crops are mainly millet (ragi), grain sorghum (jowar), and pigeon peas. They sow chick peas with the millet. Sugarcane is grown under irrigation. This is a beautiful sunny, clear morning like one of early May in Washington. At least a part of this city is very nice with wide streets and fine buildings. A beautiful new legislative building of granite is just being completed. I see many bouldery outcrops of blackened granite within the city.

I am taken to the West End Hotel. We have a hurried breakfast and leave for the field at 9:35. Besides Dr. Raychaudhuri and his secretary, Mr. Sood, we have Mr. Govindanrajan, the correlator, Dr. Donahue, Dr. Muhr, and Dr. Olsen. We go east and then north-east from Bangalore. I am told that this State of Mysore has a variety of agricultural situations since the rainfall varies from 18 inches to more than 300 inches. We drive over red lateritic soils from granite. They are said to be mostly sandy loams. We pass gullied land where the gullies have cut through the "C" on 8 percent slopes.

I am told that there are three soil surveyors working here financed by the Center but that none are supplied by the State.

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K. Rajagopalan
B.Sc. Ag., Assoc. I. A. R. I.,
Soil Survey Assistant
Red Soils Zone
Bangalore-3

ed on the left side of the
near the 8th mile stone - in
tion - 2600' - Full of weeds.

me of the village is Kenchanahalli.

It comprises of two hamlets viz. Pategeri and Adegevadarahalli.

Population: The population of the village is about 500.

Crops: Ragi (*Elucine coracana*) is the main millet and staple food for the villagers. The crop is purely rainfed. Paddy (*Oryza Sativa*), Jowar (*Sorgum vulgaris*), Samai (*Sataria Italica*), Horsegram (*Dolichos biflorous*), Castor (*Recines Communis*), Red gram (*Cajanus cajan*) etc. are the other crops grown.

Manure: Cowdung and Farm-yard manure together with tank silt is applied.

Irrigation: The crop is purely rainfed. There is no irrigation channel or river.

Rainfall: Rainy season is from April to November. October is the month in which this area gets the maximum rainfall, - about 18"; *Total Rainfall: 34"*

Yield: Main crop Ragi (*Elucine coracana*) is approximately 2 kandigas - 400 seers. *Per Acre.*

Land holdings: Varies from 1/2 an acre to 10 acres.

Cattle: Almost every family in the village owns cattle and sheep.

Industry: There is no cottage industry like weaving, pottery etc., Almost 80% of the villagers are employed in the city in various concerns and factories (Government Electric Factory, REMCO, Mysore Machines, Krishna Mills and Binny Mills). The produce from their land, Ragi-Elucine coracana, is only for their home consumption. Ragi stalk is the main food for their cattle.

Education: There are three primary schools one in each village. Only about 10% of the population are educated.

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The pit is situated on the left side of the Bangalore - Mysore Road near the 8th mile stone - in the virgin land. - *Elevation - 2600' - Full of weeds.*

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Soil:- Sandy loam to Silty loam.

Profile features:

Though the pit is abrupt at the first sight but after a deep study 3 different zones could be identified by mere change in colour, slight variation in texture and light concretions:

0- 30" *A*

Pale yellowish brown in colour. Low in organic matter. Concentrated lateral roots. Silty to sandy loam in texture.

30"-40" *B₂*

Second layer brownish yellow in colour - compact loamy to silty loam in texture. Here the concentration starts with reddish brown and black streaks.

40"-68" *B₃*

The last layer is moist. Deep brown in colour. Silty clay to clayey loam in texture. May be rich in Iron.

On the whole the soil is very deep, well drained, highly porous - easy penetration for roots.

K. Rajagopalan
B.Sc(Ag); Assoc. I.A.R.
Soil Survey Assistant
Red Soils Zone
Bangalore - 3

Soil: - 100% to 110% clay.

Profile features:

Though the pit is deep at the
first stage but after a deep study, different
could be identified in some places of colour, texture
variation in layers and light concretions:

Below yellowish brown in colour. Low
organic matter. Concentrated lateral
roots. Silty to sandy loam in texture.
Second layer brownish yellow in colour
compact loamy to silty loam in texture.
Here a concentration of roots with
reddish brown and black streaks.

The last layer is moist. Deep brown
in colour. Silty clay to clayey loam
in texture. Very rich in iron.

On the whole the soil is very deep,
well drained, highly porous - easy penetration for roots.

We stop to look at a red soil in an old field of grain sorghum. The slope is about 2 percent. It is said to be about 10 feet to hard rock. This appears to me to be a rather old landscape, developed under conditions more humid than at present. A new erosion cycle is well started to work on it.

- I. A_p 0 - 6" Reddish-brown (5YR 4/3) light sandy loam, with no regular breakage. The soil is brittle and easily friable.
- AB 6 - 9" Transitional
- B_2 9 - 24" Yellowish-red (5YR 4/6) sandy clay with some coarse quartz sand. There are some dark reddish-brown (2.5YR 3/6) large splotches on the faces of prisms. I see no clay skins. The soil breaks into fairly hard, irregular blocky aggregates.
- B_3 24 - 32" Red (2.5YR 4/7) coarse sandy clay with many large quartz particles of fine gravel size. The soil is massive in place but digs out fairly easily and is easily friable when crushed. The material is very sticky when wet.

II.

- B_u 32 - 44" This is a stone line of mixed quartz and soil material. The quartz fragments average about 1 inch in diameter.
- B_3 44 - 60+ Dark red (2.5YR 3/6) sandy clay. Although there is much sand the soil is very sticky when wet. It is massive when dry but digs out in fairly easily friable pieces.

There is a lighter colored, less sticky C of irregular thickness beneath, judging from road cuttings. Perhaps this soil would be best classified as some kind of intergrade between Red Latosol and Non-Calci Brown. I am amazed here to find that the local soil scientist

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K-2431. Jan. 21, 1958. 27 miles northeast of Bangalore. Gully in Red Latosol caused by bad highway engineering. (Govindanrajan).



K-2430. Jan. 21, 1958. Northeast of Bangalore. Landscape on red soil, long cultivated; probably intergrade between Red Latosol and Non-Calcic Brown.

had completely missed the stone line and its significance, just as they had at Hazaribagh. We drive on northeast and pass many outcrops of doloritic boulders. A new erosion cycle is beginning in this undulating landscape. Erosion and runoff control will be difficult, partly because of the low permeability of the B₂ horizon.

We pass a large pond made by damming the South Benner River. This water is used for irrigation and I see grapes, cabbage, coconuts, and date palms for "toddy." The cultivators remove some of the "silt" from the reservoirs and spread it on the land.

There is some irrigation from wells for fruits and vegetables in favored places.

We drive out along way to see road cuttings of very old red honey-combed laterite. We look at some of these about 29 miles from Bangalore. I suspect that the small areas now occupied by these hills were flat, slightly depressed uplands in the previous landscape. In these places the Laterite formed under the following erosion cycle, the intervening areas eroded away quickly leaving the laterite hills. In turn, this laterite has become highly weathered and now seems to be eroding fairly rapidly itself.

I stop to look at a pit in a young soil from alluvial material from the hills of laterite. The material has undergone very little change and the soil is essentially dark red (2.5YR 3/6) laterite clay throughout, except for the disturbed surface. I might have

had completely missed the stone line and its significance, just as they had at Hazaribagh. We drive on northeast and pass many outcrops of doleritic boulders. A new erosion cycle is beginning in this undulating landscape. Erosion and runoff control will be difficult, partly because of the low permeability of the B₂ horizon.

We pass a large pond made by damming the South Banner River. This water is used for irrigation and I see grapes, cabbage, coconuts, and date palms for "toddy." The cultivators remove some of the "silt" from the reservoirs and spread it on the land.

There is some irrigation from wells for fruits and vege-

tables in favored places.

We drive out along way to see road cuttings of very old red honey-combed laterite. We look at some of these about 20 miles from Bangalore. I suspect that the small areas now occupied by these hills were flat, slightly depressed uplands in the previous landscape. In these places the laterite formed under the following erosion cycle, the intervening areas eroded away quickly leaving the laterite hills. In turn, this laterite has become highly weathered and now seems to be eroding fairly rapidly itself.

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K-2487. Twenty-seven miles northeast of Bangalore. View of old laterite with much alumina. These mounds are erosion-resisting laterite from an older, higher landscape. (Dr. Raychaudhuri.)

and completely altered the scene from the original
and as they had no knowledge of the situation and
were very ignorant of the situation of the country.

6.2

h 3-87

K-2487. Twenty-seven miles northeast of Bangalore. View of old laterite
with much alumina. These mounds are erosion-resisting laterite from an
older, higher landscape. (Dr. Rajchanshankar.)

very typical of the laterite hills. In fact, this laterite
has been slightly weathered and was found on the ground level
locally.
I saw it first in a hill at a distance of about 10 miles
from the hills of laterite. The weathered and eroded
surface and the fact that it was found on the ground level
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Kellogg and termite mound near Bangalore.
January, 1958. (Photo by Roy L. Donahue.)



Mr. Govindanrajan and Kellogg looking at
laterite near Bangalore. (Photo by Roy L.
Donahue.)

ROY L. DONAHUE
222 ROAD 7, BENTLEY HILLS
HUTCHINSON, Kansas
INDIA

1

New Hampshire
Hutchinson

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HUTCHINSON, Kansas
INDIA

1

New Hampshire
Hutchinson



K-2488. Twenty-seven miles north of Bangalore. A young termite mound on Red Latosol.

Same line near Bangalore, (K-2488)

613

K-2488. Twenty-seven miles north of Bangalore. A young termite mound on Red laterite.



Kankar on surface, near Bangalore (R.L.D.)



Stone line near Bangalore. (R.L.D.)

3

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copy

Kankar on surface, near Bangalore (R.I.D.)

ROY L. CONAHUE
275. ROAD 7, BURLINGAME
BERKELEY, CALIF. 94708
U.S.A.

4

*How low
will you go*

Stone line near Bangalore (R.I.D.)

called this one an Earthy Red Latosol.

We stop to look at some gullies caused by very bad highway planning. The highway engineers have made road ditches that are quite long. The water in these road ditches, plus some from the field bunds, is concentrated from a wide area into a culvert at the low point between two long swells. Both the lower parts of the side ditches and the soil beyond the culvert are deeply gullied.

On the way back to the city we pass paddy under irrigation that is now some 12 inches high. I am told the cultivators use about 30 pounds of nitrogen and get a yield of around 2000 pounds per acre.

I stop to watch the cultivators threshing ragi, a kind of millet. They smooth off a level piece of ground and make the surface hard by painting it with a mixture of cow dung and water. This ragi is a dryland crop and yields about 300 to 400 pounds per acre. It is commonly grown in a mixture with chick peas and other pulses. It grows during the late monsoon after a summer fallow.

The cultivators here seem somewhat healthier and enormously better off than those I had seen earlier.

We are back to the hotel for lunch about 1:30 and then go out to the Soil Survey Laboratory and headquarters. They show me maps of an area in Mysore, one in Mysore and Kerala, and one in Andhra Pradesh. In the second area they have mapped 8 soil series at a

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scale of 1 inch equals 1 mile. In the first one they had 6 series plus the Lithosol. They had a clayey, alluvial, and gravelly phase of some of the series. The maps do not look convincing to me. I find it very difficult to understand their system. First of all, they block out the paddy land but suggest that they may come back later and map it; then they block out the hilly and non-arable land; so that their present effort seems to be confined to soils suitable to crops other than paddy.

I am told that the maps are made at "roughly" 1 inch equals 1 mile. Obviously they must use a larger field scale if the boundaries are to be accurate in relation to the boundaries of the cultivators' holdings.

Then they tell me that it is very difficult to attract men to the soil survey work because of low pay, low travel allowances, and limited scope. The first two items I think have some substance. Here the field assistants and the drivers get 1 and 1/2 rupees per day for subsistence in the field. But they have all the scope in the world if they will take advantage of it.

Now I am told that I have to go to the agricultural college. But before going I have to have a quick cup of tea here with the staff.

When I get to the agricultural college I am met by the principal and many of the students and faculty. The campus is decorated for this event and I am given high tea. Then I find I must address the entire student body. Pretty short notice! Especially when I am tired enough to drop. As I rise to speak the students cover me with

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The Mysore Agricultural Students' Association

AGRICULTURAL COLLEGE AND SCHOOL, HEBBAL, BANGALORE-6.

Dr. C. E. KELLOGG

(Head of Soil Surveys of United States Department of Agriculture)

will address the Members of the above Association

at 5 p.m. on 21st January 1958.

at the Agricultural College.

Sri. K. H. SRINIVASAN

(Former Director of Agriculture, Mysore State)

will preside.

You are cordially invited.

B. Venkoba Rao,
Rector and Principal.

A. D. Kushalappa,
President.

S. Parameswarappa,
Secretary.

TEA: 4-00 P.M.



With staff of soil correlation laboratory in Bangalore,
January 21, 1958 (S.P.R.)



At the Agricultural College, Hebbal, Bangalore, January 21,
1958. (S.P.R.)

36

With staff of soil correlation laboratory in Bangalore,
January 21, 1958 (S.P.R.)

37

At the Agricultural College, Hissar, Haryana, January 21,
1958. (S.P.R.)



Valley bordered by hills protected by laterite. (R.L.D.)



Partially weathered, exposed laterite crust (R.L.D.)

5

up

Valley bordered by hills protected by forests (P.L.O.)

6

up

Partially weathered, exposed laterite crust (P.L.O.)

two huge garlands of flowers. Anyway, I go ahead and tell them about the place and importance of soils in soil conservation and in the economic development of India.

At last this is over about 6 o'clock. I had hoped to go back to the hotel and rest, but I am told that is impossible since I am scheduled to go to Mr. McCleod's for dinner. McCleod is here advising on extension work as a member of the Tennessee team. The driver takes me down to the shopping district where I do a little dealing for 3 saris.

I am back to the McCleod's a little after 7 for dinner. It is a very plentiful dinner and most of the conversation is by the hostess about the dinner. (l'enfante terrible).

To my room about 9:30 just about as tired as I ever was.

January 22: We leave in the carry-all at 8:15 for a 186-mile trip to Ootacamund by way of Mysore. This is a bright, clear sunny morning that partly compensates for the 186 miles in a jeep. In the party are: Dr. Raychaudhuri, Mr. Govindanijan, Dr. Donahue, Dr. Muhr, Mr. Sood, and a few others who go only a part of the way.

A little ways out we stop to look at the "terrace phase" of the red soil first seen yesterday. Here also I am able to point out to the group a characteristic stone line in the road cutting.

Some of the better soils are in poor undeveloped pasture. Part of these good soils seem to be wasteland for institutional reasons. I see irrigated paddy on the low terraces.

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Published under the direction of Brigadier Gambhir Singh,
1956.

As we drive along I note that most of the soils on slopes above about 8 to 10 percent are quite shallow, nearly Lithosols. Gullies from these upper slopes commonly cut deeply through the soils on the lower ones.

We pass some sugarcane in an alluvial bottom with obvious nitrogen deficiency.

Some of these soils on easy slopes, and especially on the terraces, are not badly eroded but most of them are. Although this landscape is entering a new erosion cycle a great deal of the current erosion could be prevented with graded terraces and some land forming. Most important are diversions into prepared chutes and protection of the gullies long enough to get a good cover, which would not be difficult. I am told that the soils I am looking at have been cultivated for at least 40 centuries.

Many of the small dams in the older gullies built to store water are helping to control runoff and erosion. I am thus convinced that an erosion control program would not be too difficult to develop and carry out from a technical point of view. Some of the anthropic Lithosols have been reforested, including new plantings of eucalyptus, but very much more reforestation is needed on them.

We pass a few substantial private farm homes outside of the villages.

I see some rather poor castor beans under dryland conditions that might yield around 200 pounds per acre.

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I see some rather poor castor beans under dryland conditions that might yield around 200 pounds per acre. We pass Bahadli. Along here the easy slopes of the red soil are panned for paddy under irrigation. Some of the ponds are

3 feet high. We approach fairly high bouldery hills of granite. The lower slopes have been damaged by accelerated erosion. Along here I see more deep gullies caused by bad highway designing.

I see stacks of millet straw, poor castor beans, poor pigeon peas, mangoes, and coconut palms. Then there is some good soil on the easy slopes as we approach Closepet. To the east and west are stony hills.

We pass many irrigated mulberry plantings of small bush size for silk worms. These plantings are said to be well manured. Silk is made in this area. Then we see more irrigated paddy on the lower easier slopes of red soil.

We come to an enormous gathering of people and cattle. A cattle fair is in progress that attracts folks for many, many miles around. The place is called Jtara. Most of the people camp along the road. This fair stretches along the road for 3 or 4 miles and back from the road a considerable distance. I suppose there must be 25 or 30 thousand people here. I note that some of the animals have silk blankets. This is an amazing sight. We meet numerous processions of new comers with fine animals and music.

We pass Channapatna. This town has both silk and lacquer industries. We seem now to be in a smoother landscape. I see irrigated paddy, coconuts, mangoes, and sugarcane. It is said that some of the paddy fields here are never fallowed. Some of these crops have been cut and it looks to me that the soil is probably fallowed for a while at least.

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K-2432. Jan. 22, 1958. 8 miles south of Bangalore. Stone line in road cutting in the local "red soil."



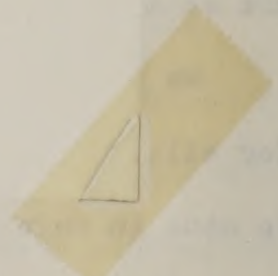
K-2433. Jan. 22, 1958. About 50 miles south of Bangalore. View of betel nut (Arecha) palm, with cactus hedge and banana interplant. Some irrigation.



III



K2432



K-2432. Jan. 22, 1958. 8 miles south of Bangalore. Stone line in road cutting in the local "red soil."



III



K2433



K-2433. Jan. 22, 1958. About 50 miles south of Bangalore. View of petrol pump (Aroclor) palm, with cocoa pods and banana interspersed. Stone investigation.

Then we pass again into dryland areas with crops on the easy slopes. On the low-lying soils are lots of coconut, which are said to be higher in quality than those grown along the coast. The elevation here is a bit lower than at Bangalore - say around 2,750 feet. There is a large area here that is nearly level to undulating with only a few slopes above 5 percent. The gray soils of the lower terraces are said to be calcareous.

We cross the Shimsa River. Along the stream there are parches of river wash in which melons are now being planted. On the south side of the river there is considerable irrigation, mostly for paddy (some of which is now growing), bananas, sugarcane, and both coconut and betel-nut palms. I try for a picture of one of these plantings of betel-nut palms (Areca catechu). The planting has a cactus hedge and interplantings of bananas. There is some irrigation from the Mysore canal.

We are at milestone 50 south of Bangalore. Even on the easy slopes here there are outcrops of dolorite. On the opposite side of the road from the palm planting I photograph a paddy field with very dark, grayish-brown surface soil. I am told that the paddy yields up to 3,000 pounds per acre. Commonly here the soils are used in a rotation of sugarcane, paddy, and a partially irrigated dry-land crop. I should guess the soils to be fairly close to Reddish-Brown Latosols.

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We continue on to Mysore 35 miles further south. There is still paddy on the easy slopes. The lower slopes have inadequate



K-2489. North of Mysore. Originally Reddish-Brown Latosol from dolorite. Now has grayish-brown surface from long use under paddy. Local washing in foreground.

organic matter. The lower soil has some hydrogen sulphide. The pH is quite high. These wet saline soils are very soft and mushy underneath. Besides the soil from the outside, straw, manure, and paddy husks are used.

Near Mandya I look at some new fields of plant sugarcane. The crop is established in a 12 to 15 months crop in either October or April. Sometimes they get two ratoons, I am told, but very do not take a ratoon crop but follow the same with another crop of plant

761

K 2489

K-2489. North of Mysore. Originally Reddish-Brown Latosol from dolomite. Now has grayish-brown surface from long use under paddy. Local washing in foreground.

We continue on to Mysore 38 miles further south. There is still paddy on the easy slopes. The lower slopes have inadequate drainage and some accumulation of salts. On slopes above 4 percent, the soil is not terraced and is rather badly eroded. This is a pity because one could make good fields here.

As we go on the amount of sugarcane increases, but still the paddy is more important. The soils not in crops are neglected to erode, even on the easy slopes. What a pity! I notice that the "silt" is removed from the irrigation ponds and applied to the soil.

As we go on I see some highly saline soils in the bottoms where the water has accumulated. I am told that near here a sugarcane company owns considerable land and operates it. Many of their fields have been reclaimed from both eroded and wettish saline bottom soils. The company has done some land forming, bunding and drainage. Many of these fields are improved by hauling in soil to cover them about 12 inches.

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cane or paddy. I am told that formerly this village of Mandya was just an ordinary cultivators village. Now as a result of the work of the sugar company it is a thriving town.

As we go on the soils on the easy slopes are generally thin and somewhat gravelly as a result of erosion. But where irrigation water can be supplied many of these eroded soils are now being reclaimed.

I am told that there is a regulation that requires the soil to be unirrigated for about one-half mile around each village as a measure to reduce malaria. Some of these "dry zones" are well farmed with dryland crops, especially millet; whereas others are wasteland or scrub pasture with truncation by both digging and erosion.

I stop briefly to look at a deep cutting in a canal. The rocks appear to be metamorphic (gneiss and schist), probably from granite, but possibly from other primary rocks as well.

About 13 miles north of Mysore I see some strongly rolling lithosolic Red Latosols used as common grazing land. The lower slopes have paddy. But some of the very thin undulating soil is also used for dryland crops.

I am told that about 5,000 acres of paddy in this area are irrigated from old canals. One crop is produced at about 5,000 pounds to the acre. The cultivators could have two crops but since the one yields so well they don't want to do the extra work!

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Looking at the metamorphic rocks in a deep canal cutting near Mysore. L. to R: Dr. Donahue; Mr. Govindanrajan; Charles E. Kellogg; and Dr. Muhr. January 22, 1958. (S.P.R.)

35

Looking at the metamorphic rocks in a deep canal cutting
near Mysore, I. to R. Dr. Donohue; Mr. Govindarajan;
Charles E. Kellogg; and Dr. Mohr. January 22, 1958.
(S.P.R.)

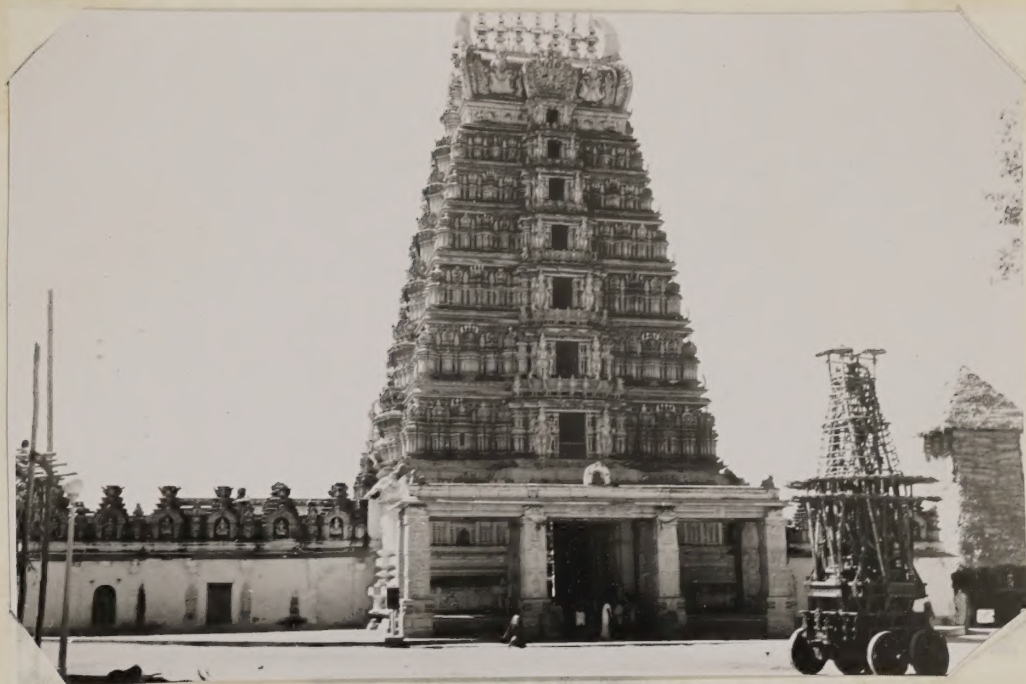
We cross the Cauvery River and pass into a mixed area of rough pasture and excellent paddy land along with some bananas. The crop pattern varies with the slope and availability of irrigation water. Near Mysore we pass through a large food-crop area with paddy, coconuts, vegetables, some bananas under irrigation, and dryland crops of castor beans, millet, and pulses.

We have lunch at the hotel in Mysore and drive on. Parts of this city are beautiful, including the personal palace of the present governor of the State, who is a former maharaja. We pass some beautiful Hindu temples and then go out into the country where there is irrigated paddy and bananas and the usual dryland crops. I guess the soil here to be an intergrade between Red Latosol and Non-Calciic Brown from granitic gneiss. I see considerable erosion but the land here is not so severely overgrazed as farther north. Many of the fields are beautifully bunded. I also pass plantings of guava and of coconut palm mixed in the paddy.

We drive through Nanjangud where we see a beautiful old temple. I am told that temples like these have planted estates for their support.

Beyond the city I see new paddy fields being prepared from soils like those we had just north of the town. These soils are not very deep over the rock except for those on the terraces. In a deep cut for an irrigation canal I see beautiful wavy stone lines

We cross the Cauvery River and pass into a mixed area of rough pasture and excellent paddy land along with some bananas. The crop pattern varies with the slope and availability of irrigation water. Near Mysore we pass through a large food-crop area with paddy, coconuts, vegetables, some bananas under irrigation, and dryland crops of castor beans, millet, and pulses. We have lunch at the hotel in Mysore and drive on. Parts of this city are beautiful, including the personal palace of the present Governor of the State, who is a former maharaja. We pass some beautiful Hindu temples and then go out into the country where there is irrigated paddy and bananas and the usual dryland crops. I guess the soil here to be an intergrade between Red Latosol and Non-Calcic Brown from granitic gneiss. I see considerable erosion but the land here is not so severely overgrazed as farther north. Many of the fields are beautifully bounded. I also pass plantings of guava and of coconut palm mixed in the paddy. We drive through Nanjangud where we see a beautiful old temple. I am told that temples like these have planted estates for their support. Beyond the city I see new paddy fields being prepared from soils like those we had just north of the town. These soils are not very deep over the rock except for those on the terraces. In a deep cut for an irrigation canal I see beautiful wavy stone lines



K-2435. Jan. 22, 1958. South of Mysore. Hindu temple.



K-2434. Jan. 22, 1958. Near Mandya, north of Mysore. New fields being made for sugarcane by hauling in about 12 to 18 inches of good surface soil to cover ill-drained, salty paddy soil.

with truncated red soil which runs for some distance below
them. Many of the low-lying hills are not very steep the
slopes above are irrigated.

Along the road the dry hot sun is very hot and a
refreshing breeze is a
temptation.

As we drive
with rough roads
ful planning of
for use. On the
but on the low

We pass by
at a black soil
discover that



of crops
with care-
relieved
It is clear,

happily
a plot and
one only

they
to the
the

to the
the

The lower soil is very dry in winter and the hills are very dry

to have a hard undergrowth. The hills are very dry

like a high hillside or perhaps an intergrade between hillside

and hillside. It is certainly a pity that my guide left the

peak at our last profile.

Kanehalli temple near Mysore, January 22,
1958. (S.P.R.)

with truncated red soil above them and weathered schist below them. Many of the low-lying soils are wet and salty where the slopes above are irrigated.

Along the road one may buy opened green coconuts for a refreshing drink. But it is not hard for me to resist the temptation.

As we drive on most of the soil is used for dryland crops with rough scrubby pasture on eroding sloping areas. With careful planning of water control much of this could be developed for use. On the crests and in the eroded areas the soil is thin, but on the lower slopes the soil is deep.

We pass Begur, a small village and I stop to look hurriedly at a black soil that is almost level. (I miss my little pick and discover that these India soil scientists do not even have one!)

- | | | |
|----------------|-------|---|
| A _p | 0- 5" | Very dark grayish brown (10YR 3/2) clay with medium prismatic structure that falls into medium blocky that is very hard when dry. |
| B ₅ | 20+ | Black (10YR 2/1) clay with medium to coarse prismatic structure that falls into hard medium angular blocky. The B has a few small concretions of calcium carbonate. |

The lower soil is said to be salty in places and much of it is said to have a hard crôte calcaire underneath. This soil looks to me like a weak Solonetz or perhaps an intergrade between Solonetz and Rendzina. It is certainly a pity that my guides left the pick at our last profile.

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Very dark grayish brown (10YR 3/2) clay with medium prismatic structure that falls into medium blocky that is very hard when dry.

Ap 0 - 2"

Black (10YR 2/1) clay with medium to coarse prismatic structure that falls into hard medium angular blocky. The B has a few small concretions of calcium carbonate.

B2 20+

The lower soil is said to be salty in places and much of it is said to have a hard croute calcare underneath. This soil looks to me like a weak Solonchok or perhaps an intergrade between Solonchok and Rendzina. It is certainly a pity that my guides left the pick at our last profile.

- 18 -



K-2436. Jan. 22, 1958. South of Mysore. Preparing new paddy fields with bunds on intergrade between Red Latosol and Non-Calciic Brown.



K-2437. Jan. 22, 1958. Near Begur, a small village south of Mysore. A field used for sorghum after the monsoon with kankar in the surface - an intergrade between weak Solonetz and Rendzina or Tropical Black Clay.

On this soil sorghum grows during the monsoon. In plowed fields I see some concretions of calcium carbonate (kankar) on the surface. Coconuts do not do well here because of the excess lime and salt. I see the usual red soil in the background hills.

As we go the soils with gently undulating relief are very red indeed. I suspect that the soils themselves are developed from old "drift" derived mainly from dolomite. But I discover that this intensive red soil occupies only a small area.

We pass Gundlupet. For many miles along this road banyan trees have been planted. But the cultivators keep cutting off the new aerial roots so that the trees have only a single trunk.

We are soon in a forest reserve. I see sandalwood trees along with other species planted around them to protect them. This is said to be necessary for the sandalwood trees to get nutrients. Maybe so. We are now in the hilly foot slopes below bold, low mountains. The soils are less red in color and are lithosolic over a country rock that is mainly gneiss (?). The forest is a bit scrubby and thin. Some of the plantings include teak and others bamboo. I am told there are wild elephants here but I don't see any. As we cross from Mysore State into Madras State, the surface soils are very dark brown with reddish-brown soil beneath. Here I see bananas, tapioca, paddy in the lowest places, some guava, and some tea gardens.

We pass Gudalur here in the mountains. I see some more rather poor tea gardens under silvery oak on Reddish-Brown Latosols from diorite.

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K-2438. Jan. 22, 1958. North of Ootacamund. Termite mound of
of Reddish-Brown Latosol.



—K-2439. Jan. 22, 1958. North of Ootacamund. Tea garden under
silver oak. Poor stand of tea. Reddish-Brown Latosol.



K2438

K-2438. Jan. 25, 1958. North of Ootacamund. First record of
of Reddish-brown Lizard.

8-2



K2439

K-2439. Jan. 25, 1958. North of Ootacamund. First record under
silver oak. Poor stand of oak. Reddish-brown Lizard.

I meet several young men working here on the soil conservation experimental station and training center. Progress is slow on this very winding mountain road. We shall be late again because my Indian guides have little or no concept of either time or distance.

The soils from granitic gneiss are dark brown in the surface and pinkish red beneath. Some of these mountains are formed of complexes of gneiss and dolorite.

At about 6,000 feet there are several tea gardens along with some cinchona. The forest has been removed from many of the high hills. This is too bad. But new plantings are recently being made. As we go on I see some beautiful tea gardens and we meet the workers with their picking baskets. In some of these gardens they have drainage ditches directly down the slope, as one sees in tobacco fields in Puerto Rico. We also pass some plantings of wattle for paper.

We come to the Moyar River south of the hydro-electric dam. The road goes above 7,000 feet. From the cuttings I see black surface soil in the drainage ways.

As we approach Ootacamund I see potatoes on slopes up to 25 percent, even on yellowish-red soils that are certain to erode. I am told that potatoes were introduced into this Ooty Valley about 1849. The same man unhappily introduced gorse from Scotland, which has become a great nuisance here as in New Zealand.

This town of Ootacamund in the mountains is an old resort place. Many of the early princes had summer palaces here. We arrive at our hotel just a bit after 6.

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I meet several young men working here on the soil conservation experiment station and training center.

I have a late dinner and to bed. The air is very cold.

January 23: I am up at 6:30 with a fireplace fire and tea.

They have nice gardens here and I see one poor struggling azalea. I am told that this area has 34 inches of rain that comes mainly in May and October.

I have breakfast and leave at 8:20 for the Rees Corner Central Soil Conservation Research Farm. Around the town and beyond its margins are many eucalyptus trees and other tree plantings. Within the town there is a nice little lake and stream.

The staff showing me about here includes the following besides the party that started with me:

Dr. Regge, soil conservation officer in charge

Mr. Narayanswami, the soil conservation engineer

Mr. Shanmugham, an engineer from Madras State

In the country I see potatoes on 25 percent slopes of Reddish-Brown Latosol. Many of the cultivators have terraces that reduce the slopes to 5 or 6 percent, but these are neither properly graded nor on the contour. Yet the soils are so permeable that erosion is not serious on most of the fields.

The cultivators lop the eucalyptus trees and use the materials for making oil. They lop them too much and leave only a little cluster at the top.

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K-2490. North of Ootacamund, near Gudalur. Landscape on Reddish-Brown Latosol. (Bananas, coffee, tapioca.)

K-2491. Jan. 23, 1978. View of the hills, showing the steeply sloping, Reddish-Brown Latosol and the vegetation. The plantings of eucalyptus. The trees are tapped for latex for distillation. (K-2491.)

7.5

K-2490

K-2490. North of Ootacamund, near Gudalur. Landscape on Reddish-Brown
 Latosol. (Bananas, coffee, tapioca.)



K-2440. Jan. 23, 1958. Ootacamund. The Savoy Hotel in early morning sun.



K-2441. Jan. 23, 1958. Near Ootacamund. Terraced, strongly sloping, Reddish-Brown Latosol used mainly for potatoes. Some plantings of eucalyptus. The trees are lopped too much for distillation. (Misty).



K2440



K-2440. Jan. 23, 1958. Ootacamund. The Navy Hotel in early morning sun.

11-4



K2441



K-2441. Jan. 23, 1958. Near Ootacamund. Terraced, strongly sloping, reddish-brown laterite used mainly for potatoes. Some plantings of eucalyptus. The trees are lopped too much for distillation. (Misty).

I am taken to a high hilltop. The soil is said to be all from granitic gneiss but I am convinced that at least part of it is influenced by either dolorite or some other more basic rock. Here again I see the inevitable runoff plots besides engineering trials with terraces and trenches at different depths. These bench terraces should be graded. They have quite an area around this hill with bench terraces at a slight grade. These terraces have very steep front slopes and their surfaces have a slight back slope. Then straight down the slope they have a deep ditch, dug down to the rock, for drainage of the bench terraces. I try to photograph this slope from the top, including the deep trench for drainage that is some 2 feet wide and 2 to 6 feet deep. Just in front of each bench they have made a kind of hole or plunge pool to absorb the force of the water. These holes are to be sodded.

These works are made with bulldozers and tractors. In the process they have dug up the soil greatly but I am told that yields are as good when the new surface soil is made from the C horizon as from the A or B. The construction of these bench terraces with back slopes of $1/2$ to 1 percent and grades of about $1/2$ percent result in a loss of area of around 20 percent.

The cultivators commonly use about 2,000 pounds of 10-5-5 fertilizer made basically from ammonium sulphate, superphosphate, peanut cake, and potassium sulphate. They also use barnyard manure and some lupines for green manure.

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K-2442. Jan. 23, 1958. Near Ootacamund. Looking from the experimental area. A drainage ditch for the back-sloped bench terraces goes straight down the hill. Soil for potatoes in right background.



K-2443. Jan. 23, 1958. Near Ootacamund. A view of Ketty Valley in which the conservation work has been concentrated. Reddish-Brown Latosols.



12442

K-2442. Jan. 23, 1958. Near Gocassum. Looking from the experimental area. A drainage ditch for the back-sloped bench terrace goes straight down the hill. Soil for potatoes in right background.



12443

K-2443. Jan. 23, 1958. Near Gocassum. A view of Katty terrace - Valley in which the conservation work has been concentrated. Reddish-Brown latosols.

They also have some plots to study the effects of various kinds of trees in controlling runoff and erosion.

I am told there is considerable experience about reforestation.



except it. On slopes above 33 percent either protected gardens or reforestation with graded trenches is recommended.

K-2491. Near Ootacamund. Looking down the ditch that carries water from the experimental bench terraces, which are made with a slight back slope. Soil in right background is used for potatoes.

Reddish-brown Latosols from granitic gneiss with some outcrops of dolerite. Most of the slopes are greater than 10 percent, although there are small areas of alluvial soils used for vegetables.

7.6

K 2491

K-2491. Near Otacumund. Looking down the ditch that carries water from the experimental bench terraces, which are made with a slight back slope. Soil in right background is used for potatoes.

They also have some plots to study the effects of various kinds of trees in controlling runoff and erosion.

I am told there is considerable argument about reforestation in these mountains. Some of those concerned with the development of maximum hydro-electric power maintain that reforestation reduces the water yield. I suppose it might a little, but it certainly greatly increases the life of the reservoirs and furnishes a very valuable product.

I am told that the blue gum eucalyptus grows well here and is used for both charcoal and fuel. The making of oil from the leaves is a cottage industry. This crude oil produced by the cultivators needs further refinement before marketing. I am told that for slopes of 10 to 16 percent graded trenches are recommended to the cultivators and graded bench terraces on slopes of 16 to 33 percent. It is explained that 25 percent would be a better maximum but that the cultivators will not accept it. On slopes above 33 percent either protected pasture or reforestation with graded trenches is recommended.

As we drive on a bit the soils seem to be mostly Red and Reddish-Brown Latosols from granitic gneiss with some outcrops of dolorite. Most of the slopes are greater than 10 percent, although there are small areas of alluvial soils used for vegetables.

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Reddish-Brown Latosols from granitic gneiss with some outcrops

of dolomite. Most of the slopes are greater than 10 percent,

although there are small areas of alluvial soils used for

vegetables.



At Ootacamund, January 23, 1958.

L. to R: S. Narayanswami, Dr. N. D. Rege, S. K. Sood,
and Charles E. Kellogg. (R.L.D.)

I am told that the cultivators with low uneven bunds that only reduce the slope slightly lose around $3\frac{1}{2}$ tons of soil per acre each year under cultivated potatoes. Considering the length of time these soils have been used I feel sure that this figure is too high. On some of the sloping soils I see some nice little tea gardens, but most of the land is now used for potatoes. This crop was stimulated during World War II. I am told that many of the potatoes are shipped to Calcutta. I would not have thought it practicable to ship them so far.

I see many small patches of soil with 30 percent slopes less than $\frac{1}{4}$ acre in size used for potatoes. Some of these will not last very long.

We stop to have a look at the Ketty Valley. The soils are rolling to steeply sloping Reddish-Brown Latosol, I think. I see potatoes, barley, wheat, oats, millet and, in the low places, vegetables, strawberries, and raspberries.

Conservation extension work is being emphasized here on 13,000 acres of which about 5,000 are used for potatoes. The cost of the terracing work includes the time of the technicians, labor, and other costs. The cultivators receive 25 percent of this as a subsidy but each must pay back 75 percent of the cost within 20 years plus $5\frac{1}{4}$ percent interest. It seems to me that this is far too high and that the subsidy should be at least 50 percent.

I am told that the cultivators with low uneven bunds that only reduce the slope slightly lose around 3½ tons of soil per acre each year under cultivated potatoes. Considering the length of time these soils have been used I feel sure that this figure is too high. On some of the sloping soils I see some nice little tea gardens, but most of the land is now used for potatoes. This crop was stimulated during World War II. I am told that many of the potatoes are shipped to Calcutta. I would not have thought it practicable to ship them so far.

I see many small patches of soil with 30 percent slopes less than 1¼ acre in size used for potatoes. Some of these will not last very long.

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I am told that they have 2,500 acres now planted and more to come. They have also 20,000 acres planned for tea plants for the tea gardens. The work also includes some drainage in the lowlands along the streams for cross water irrigation.



and northern Queensland.

-2492. Near Ootacamund. Tea garden on Reddish-Brown Latosol.

We go down a very winding road with many sharp hairpin and scoble hairpin curves. The valley here is exceedingly steep and V-shaped from 5,000 feet down to less than 1,500 feet during a distance of 20 miles. The steep slopes of the Bhavani River are well covered with trees and shrubs in a nice preserve. I can hear the roar of the waterfalls and of the rapids far below the road.

I am told that the collection was for the purpose of
 only under the single leafy leaf of the
 with the same collection. The collection is
 of the same leafy leaf of the same leaf of the

27

12492

2492. Near Ootacamund. Tea garden on Reddish-Brown Latosol.

leafy, and other parts. The collection is for the purpose of
 as a whole. The leafy leaf of the same leaf of the same
 within 20 years of the present collection. The leafy leaf of the same
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The maximum elevation of the hills is 8,600 feet. This is one of the most beautiful valleys I have ever seen. It reminds me of Ruanda and the eastern highlands of the Belgian Congo. What wonders the Italians would do here with their masonry bench terraces and chutes!

We drive in the directions of Coimbatore, past Wellington, an advanced military college for staff officers.

We pass Coomoor. The local railway has a cog track in the center for the heavy grades. Now the hills are shrouded in low clouds. Besides the bad gorse, I note also that lantana has gone wild here and become a serious nuisance as it has in Hawaii and northern Queensland.

We go down a very winding road with more than a score of sharp hairpin and double hairpin curves. The valley here is exceedingly steep and V-shaped from 6,000 feet down to less than 1,200 feet during a distance of 20 miles. The steep slopes of the Bhavani River are well covered with trees and shrubs in a nice preserve. I can hear the roar of the waterfalls and of the rapids far below the road.

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For the first time I see jak fruit trees. These are medium-size trees with long brown hanging fruit some 5 to 6 inches in diameter and 10 to 14 inches long. These are used as food. Teak again appears below 3000 feet along with sandalwood; and I notice a few rubber trees.

We pass Burliar, a very small place where there is a fruit station for steep hill culture. But I see few places for fruit. As we drive along, the air is much warmer. The soils are Red and Reddish-Brown Lithosols, mainly from gneiss and dolorite. Then we pass Kallar another fruit station where I see thin stands of betel nut on alluvial terrace near the stream. This alluvial terrace widens out and we drive onto a large wettish area with irrigated palms. The water is held by low bunds as for paddy. Then we come onto a large area of irrigated paddy. I am told that month-old seedlings were planted in August. The paddy is full height and part of it is lodged. I see also bananas, castor beans, coconuts, and cotton.

We come to Mettubalayam and cross the Bhavani River. Here the river is large. There are many small shops and the usual crowded streets, although there are few bullock carts.

We are now on undulating red soil developed partly from "drift" and partly on thin slopes with many rough outcrops. Again the rock seems to be a mixture of mainly granitic gneiss with some

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We come to Mettupalayam and cross the Bhavani River. Here the river is large. There are many small shops and the usual crowded streets, although there are few bullock carts.

We are now on undulating red soil developed partly from "drift" and partly on thin slopes with many rough outcrops. Again the rock seems to be a mixture of mainly granitic gneiss with some

dolorite. There are poor crops of millet, some fallow, and considerable rough pasture. I see some small fields irrigated from wells, with paddy, some short-staple cotton, and some tobacco. irrigated. Plantings of palmyra palm near the city look As we drive along the number of bullock carts increases. Both bullocks and carts are smaller than in north India. I am told This soil is also fairly erosive especially on the slopes in the overgrazed areas. the people seemed a little put out that Then we come into an area with locally irrigated sugarcane along with cotton, bananas, tobacco, dryland millet, and some "horse gram." Tamarind trees are planted along the road. Rights to harvest fruit from these trees are sold at auction to help support the highway. There are also some pomegranates and papaya. The rainfall has dropped considerably and yields of crops on un-irrigated soils are low. There is little vegetation to protect sloping ones from erosion. short they insist that I look at two pits. I am told that wealthy land owners here are able to make deep wells and lower the water table to the point where the shallower wells of the ordinary cultivators go dry. sh-brown (10YR 3/2)

We come into a smooth area with very dark colored surface soils that are said to be limy beneath. grayish-brown (10YR 3/2 to 2/2) sandy clay loam that is fissive

We are now driving very rapidly because we are behind our schedule as usual. The lower boundary is wavy and varies here in the pit from 20 to 25 inches.

B (7) 23 - 43"

Coarsely crystalline black (10YR 2/2) clay that falls into large angular blocks. Some small lime concretions.

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We are now driving very rapidly because we are behind our

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I see quite a bit of cotton near the 8 milepost before Coimbatore and also sugarcane and bananas. Farming is more intensive as we approach the city although many of the fields are not irrigated. Plantings of palmyra palm near the city look very poor.

We drive into the agricultural college about noon. I am told there are 162 students and 5 graduate students here. We were expected earlier and the people seemed a little put out that we cannot stay later.

I met Dr. Mariakulandai, State Agricultural Chemist and several of his associates including Mr. T. R. Srinavasen, assistant chemist in charge of soil testing. We drive immediately out into a smooth area on which the college has experimental plots. On the way out the chemist tells me that the parent materials are residual from granite and it looks to me like an alluvial plain.

Although time is very short they insist that I look at two pits. Perhaps 150 yards from one another, one in a black soil and one in a red soil. I look first at the black soil:

- | | | |
|-----------------|-------------|--|
| Ap | 0 - 5 1/2" | Very dark grayish-brown (10YR 3/2) heavy sandy loam which breaks irregularly into friable pieces. |
| A ₁₁ | 5 1/2 - 23" | Very dark grayish-brown (10YR 3/2 to 2/2) sandy clay loam that is massive and has only slight vertical breakage. The lower boundary is wavy and varies here in the pit from 20 to 26 inches. |
| B (?) | 23 - 43" | Coarsely prismatic black (10YR 2/2) clay that falls into large angular blocks. Some small lime concretions. |

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and one in a red soil. I look first at the black soil:
Ap 0 - 2 1/2" Very dark grayish-brown (10YR 3/2)
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C₁ 43 - 50" Yellowish-red sandy clay, massive but fairly easily friable.

C_{ca} 50 - 65" Mottled white and reddish-yellow sandy clay to clay. The soil digs out in small angular blocks that harden on exposure.

C 65 - 75+ Yellowish-brown sticky and plastic clay with some sand. Now moist.

I am able to show these people banding in the lower part of the soil resulting from the strata of the original alluvium, which I am sure came into this flat from a considerable distance. The alluvium is mainly from gneiss but partly from dolorite. Most of the soil profile is moist below about 24 inches.

I then hurry over to the pit in the red soil. Unhappily this pit has been made in a disturbed place along a ridged field border. I ignore the surface 18 inches and start at the old soil surface.

1 0 - 31" Reddish black (5YR 3/2 to 2.5YR 2/4) sandy clay loam. The soil is fairly coarsely prismatic and breaks into coarse blocky. The lower part is a small transition to the next horizon.

C_{ca} 32 - 46" Light gray concretionary calcium carbonate.

D 46+ Red (2.5YR 5/8) gravelly loamy sand, clearly stratified alluvium.

This soil is probably some kind of intergrade between Reddish Chestnut and Reddish-Brown Latosol. As I explain this profile it is clear that the chemist is a bit set back and the young men who are not permitted to comment are highly pleased.

C1 43 - 50" Yellowish-red sandy clay, massive but fairly easily friable.

C2 50 - 62" Mottled white and reddish-yellow sandy clay to clay. The soil digs out in small angular blocks that harden on exposure.

C3 62 - 75+ Yellowish-brown sticky and plastic clay with some sand. Now moist.

I am able to show these people banding in the lower part of the soil resulting from the strata of the original alluvium, which I am sure came into this flat from a considerable distance. The alluvium

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The lower part is a small transition to

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C4 32 - 46" Light gray concretionary calcium carbonate.

D 46+ Red (2.5YR 5/8) gravelly loamy sand, clearly

stratified alluvium.

This soil is probably some kind of intergrade between Reddish

Ghesbrouck and Reddish-Brown Latosol. As I explain this profile it is

clear that the chemist is a bit set back and the young men who are

not permitted to comment are highly pleased.

I think this plain was developed first as a very broad, braided stream, in places shallow over the country rock. Strands and bars of sand, gravel, and even cobbles were laid down. Later the finer sediments rich in clay were deposited by very slowly moving water. Where the clayey surface was shallow over the sand and gravel, red soils developed. Where it was deep, between the sand bars, a black soil was developed from the clay. This black soil looks to me like a good example of Tropical Black Clay.

Mr. T. R. Srinivasen and some of the others tell me that the crops are much better on the red soil than on the black soil. These younger men are glad to have my explanation. (I only hope it is right.)

We then hurry to the house of Professor Sharp for lunch. We are all Americans at lunch - Mrs. Sharp, Mr. Fay, Dr. Muhr, Dr. Donahue, and me. Things go slowly and since my plane is scheduled to leave soon I am a bit in a hurry. Then too, I am beginning to wonder if the Indians aren't changing the Americans sent here to help them more than the Americans are influencing the Indians.

After lunch we drive through the town and out toward an emergency airport that is used mainly by the military. This is a large nearly level alluvial fan with red soil, probably an intergrade between Reddish Chestnut and Red Latosol. It looks to be a very good soil where irrigated, but is probably very droughty during the long dry season. There is a good body of clay in the B horizon and good permeability. Mr. Srinivasen tells me that these soils are low in phosphorus and especially nitrogen.

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But with water for irrigation these would be responsive soils.

I am told that the rainfall at the airport is about 20 to 30 inches and the elevation 1,260 feet. The rain falls during July, August, and September with occasionally a little during December.

We go to the airport and find the waiting room locked. Now we are told that the plane will be very late; so we wait.

It is too bad they didn't tell us this plane was going to be so late. Dr. Raychaudhuri, Mr. Sood, and I wait. The others decide to go back to Bangalore in the carry-all. About 6 p.m.

Dr. Dorothy Parker joins the waiting group.

Finally we leave about 7:30 and reach Bangalore about 8:30. They are so slow with the baggage here that I am reminded of Washington. I get to the hotel just in time for a bit of dinner before the dining room closes at 9:30.

This has been a day!

January 24: I am up at 5 a.m. for breakfast. Since my Indian friends did not come at 6 a.m. as promised I go by the airline bus. During the trip to the airport the rosy dawn appears. Just as I check in for the flight to Delhi Dr. Raychaudhuri and the others come.

We leave at 7:14 a.m. for Hyderabad. From the plane I see some relatively new gullies and quite a few large ponds for irrigation. Near them are crops of sugarcane and other winter crops. But most of the fields beneath, are used for one-crop paddy. About one-third of these have been recently plowed.

The forest is mainly on the slopes and from what I can see from the plane must be exceedingly thin.

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At about 35 miles the proportion of hilly knobs and severe erosion increases. Some of the old ponds are filled with "silt." Most of the crops are dryland ones with little patches of sugarcane and paddy in favored places back of high bunds. Unless something is done erosion will certainly cut away many more fields.

Out about 100 miles the soil is darker in color. There is a good deal of eroded wasteland. We are down at Hyderabad at 8:54 a.m. I have a light breakfast. Dr. Donahue and Dr. Parker leave us here and I am off again at 10 a.m.

I am told that the rocks here are granite. From the plane the soils appear to be a yellowish-red and there are many outcrops of huge granite boulders. Most of the landscape is undulating and now brown and dry except near the many ponds. At 90 miles or so there is an increased amount of wasteland on dry hills.

As we near Nagpur the soil appears to be yellow and dry.

We are down at 11:30. It is hot and sunny here. The undulating black soil near the airport appears to be developed from basaltic trap rock. I am told that there are some fine irrigated oranges produced here.

We leave for Bhopal at 12:17. In the plane an Indian forester tells me that they are trying to grow teak here - what he callse "C.P." teak, which is somewhat less valuable than that grown under cooler and more moist conditions.

I am told that about 34 percent of this area is under forest. The forest is mainly on the slopes and from what I can see from the plane must be exceedingly thin.

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January 23: In the morning we schedule to fly to Bhopal. After a bit we appear to pass over a thin cloud of dust about 2,000 feet high. After another 100 miles or so, we pass over more strongly dissected land that seems to be mostly thin scrubby woodland with perhaps 5 to 10 percent cultivated in favored places. Part of the fields are irrigated. Then we pass over a dam with a pool of good size. Several acres at least are partially irrigated for farm land from this and other pools. The cultivated soil appears to be on old alluvial slopes and old stream terraces at low elevation. I would guess the soil to be Tropical Black Clay in the lowest areas, but the soils on the slopes are reddish-brown. I am a bit surprised at the lower percentage of black soil, perhaps 5 percent.

As we approach Bhopal we fly over a lower plain. This one is undulating also, but has more water and more green fields. But even on the easy slopes I see much erosion. These eroded fields are yellowish-brown or reddish brown.

We are down for a few minutes at Bhopal and leave at L;54 for Delhi. It is too hazy to see much of the landscape.

We are down in the Delhi airport at 4:00 and I go to the Ashoka Hotel.

I reorganize my baggage, read my mail, and have conferences with Dr. Cummings and Dr. Moseman.

After a little rest I have dinner with Dr. Moseman and we review each other's plans.

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January 25: In the morning my schedule is firmed up for the remainder of my visit in India

At 10:00 Mr. Nixon and Dr. Basu take me to the Central Water and Power Commission. Here I am taken very rapidly through a large group of laboratories and offices, especially by Dr. H. C. Hoon, Director of the laboratory dealing with soils, soil mechanics, and so on. I also meet Mr. R. D. Dhir, the chief engineer, and Dr. K. L. Rao, a member of the Board. I am shown large-scale models of water-control schemes in India as well as a few from Red China and France, and even one of Norris Dam in the United States. They tell me that irrigation projects involving over a million rupees come to the Commission for clearance and that the Commission plans many of those costing over 50 million rupees. For most of the large projects the government has a special organization. In the new 5-year plan they expect to have over 400 water control projects, including irrigation, flood control, hydro-electric power, and harbor improvements. Many of these are multi-purpose projects.

I am shown the library. Here I see 3 Red Chinese engineers at the reading tables, but nobody mentions them. I assume that they are exchange students in training.

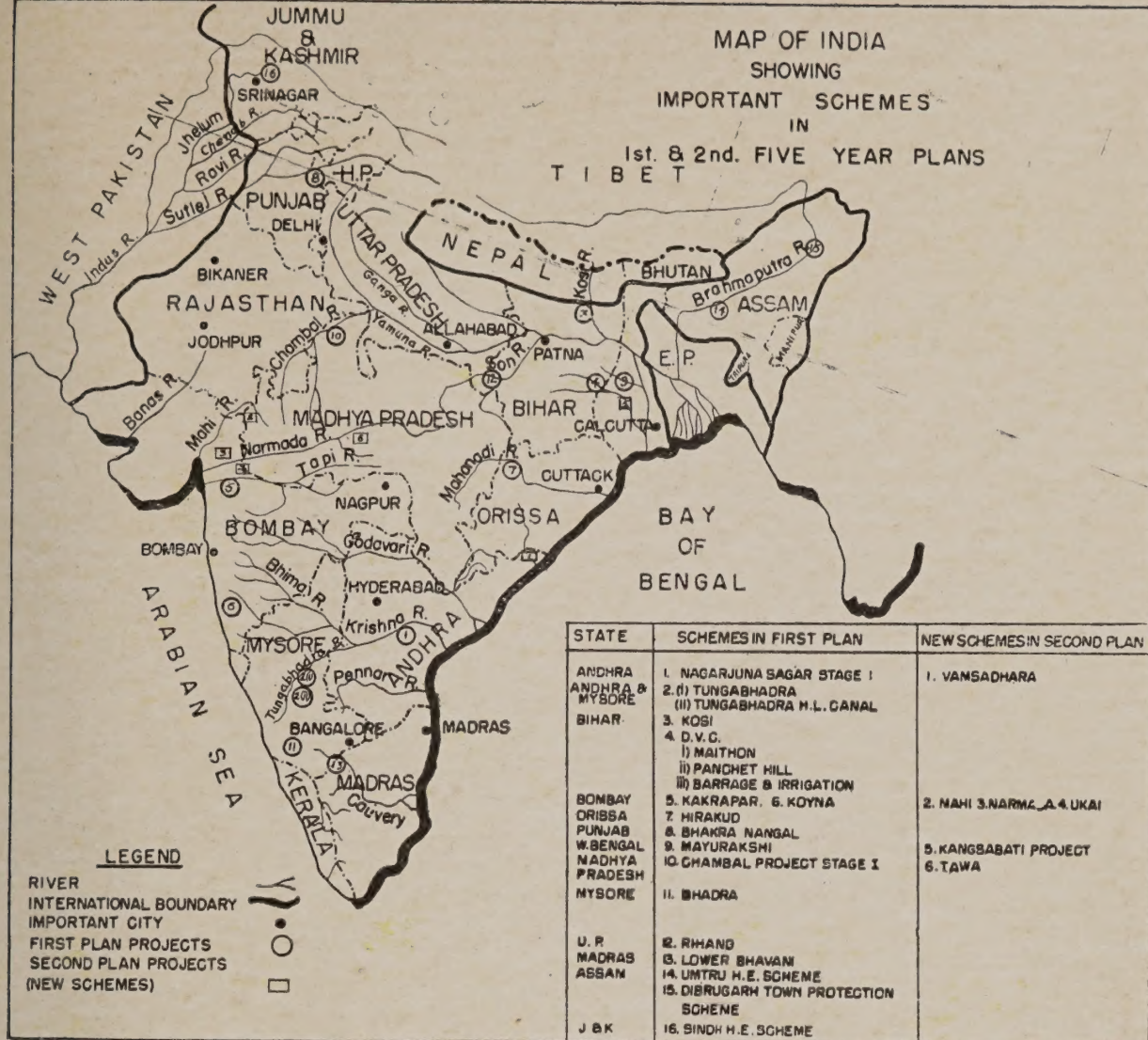
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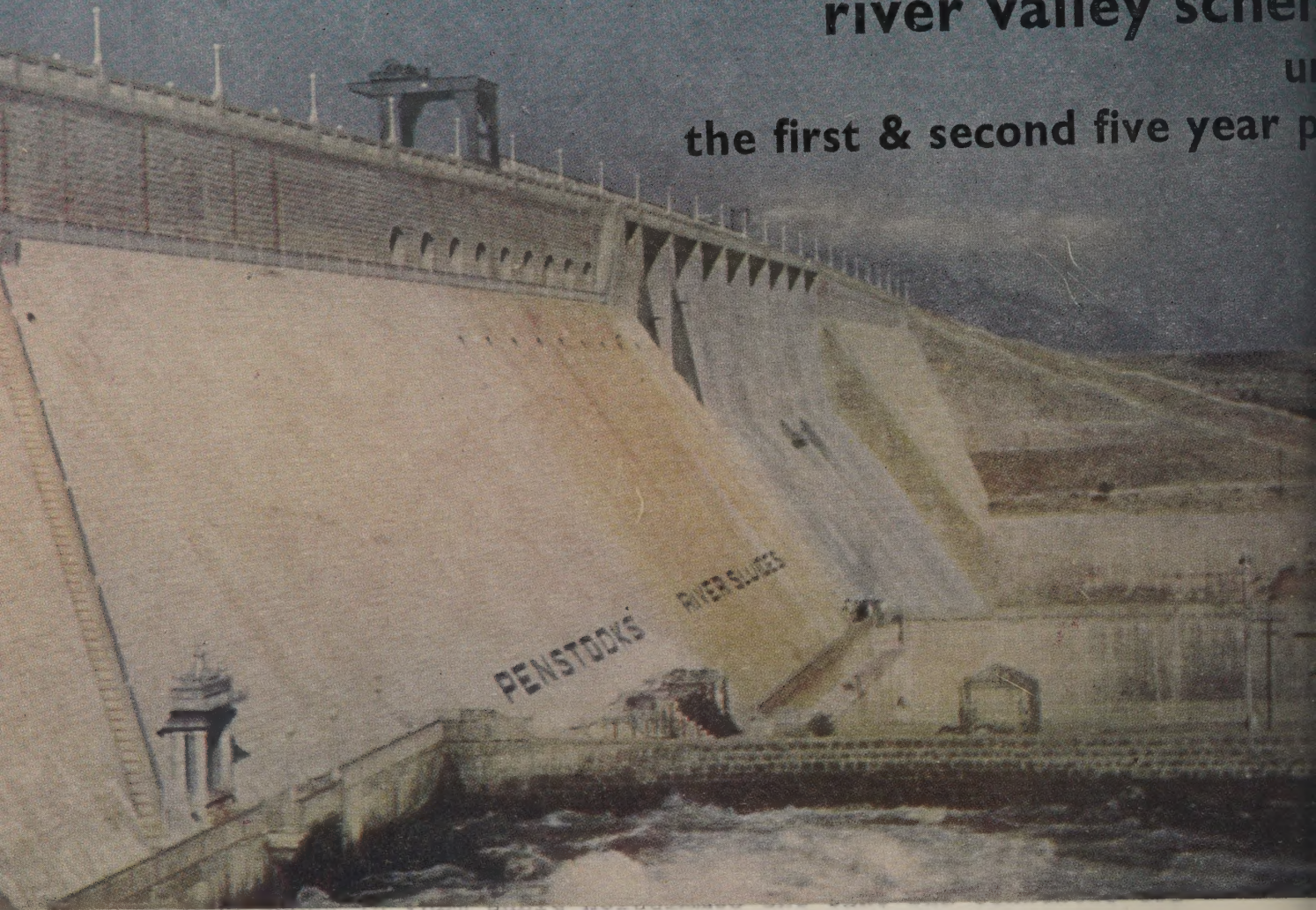
people from North Assam wear very interesting garments.

Then I return to the hotel for tea with Dr. Moseman, work awhile on a draft report, and have a late dinner with Dr. Cummings, Dr. Moseman, and several others. The dinner doesn't get under way until 9:45 so I leave before the others and go to bed about 11:00.

January 26: This is Republic Day in India and I am up early in order to go to the parade with Dr. Moseman and others. Fortunately Dr. Cummings had arranged for a nice place for us in the stand. With us are Dr. and Mrs. Frank Parker, Dr. and Mrs. Cummings, and many other Americans. In seats a bit lower down are Mr. and Mrs. M. L. Wilson. There is an enormous and colorful crowd on

a few important
river valley schemes

under the first & second five year plans



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Then I meet Professor Dr. P. R. Ahuja, Director of Hydrology and Statistics. His section is estimating the total water available by regions and gets out "yearbooks" for large catchment areas and other areas, which include all available data.

We then have tea in the office of Mr. D. Mehta, a member of the Board of the Commission, where I answer a good many questions and speak briefly on soil survey work as applied to irrigation development.

I am back at the hotel for lunch at 1:00 p.m.

After lunch Dr. Moseman and I go to a reception given by Mr. Prasad, the President of India. The reception is held in the president's beautiful garden. This is a very large affair with many beautiful saris, uniforms, and native costumes. The people from North Assam wear very interesting garments.

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Dr. C. E. Kellogg

Republic Day



2403

The President

At-Home

on Saturday, the 25th January, 1958,

(5th Magha, 1879)

at 4-00 p. m.

at Rashtrapati Bhavan, New Delhi.

AN ANSWER IS REQUESTED TO
THE A.-D.-C. IN-CHARGE OF INVITATIONS.

Please bring this card with you.

The President will arrive in the
Moghul Gardens at 4-20 p. m.

PARK

[To be placed on the Windscreen of the Car.]

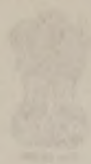
[P.T.O.]



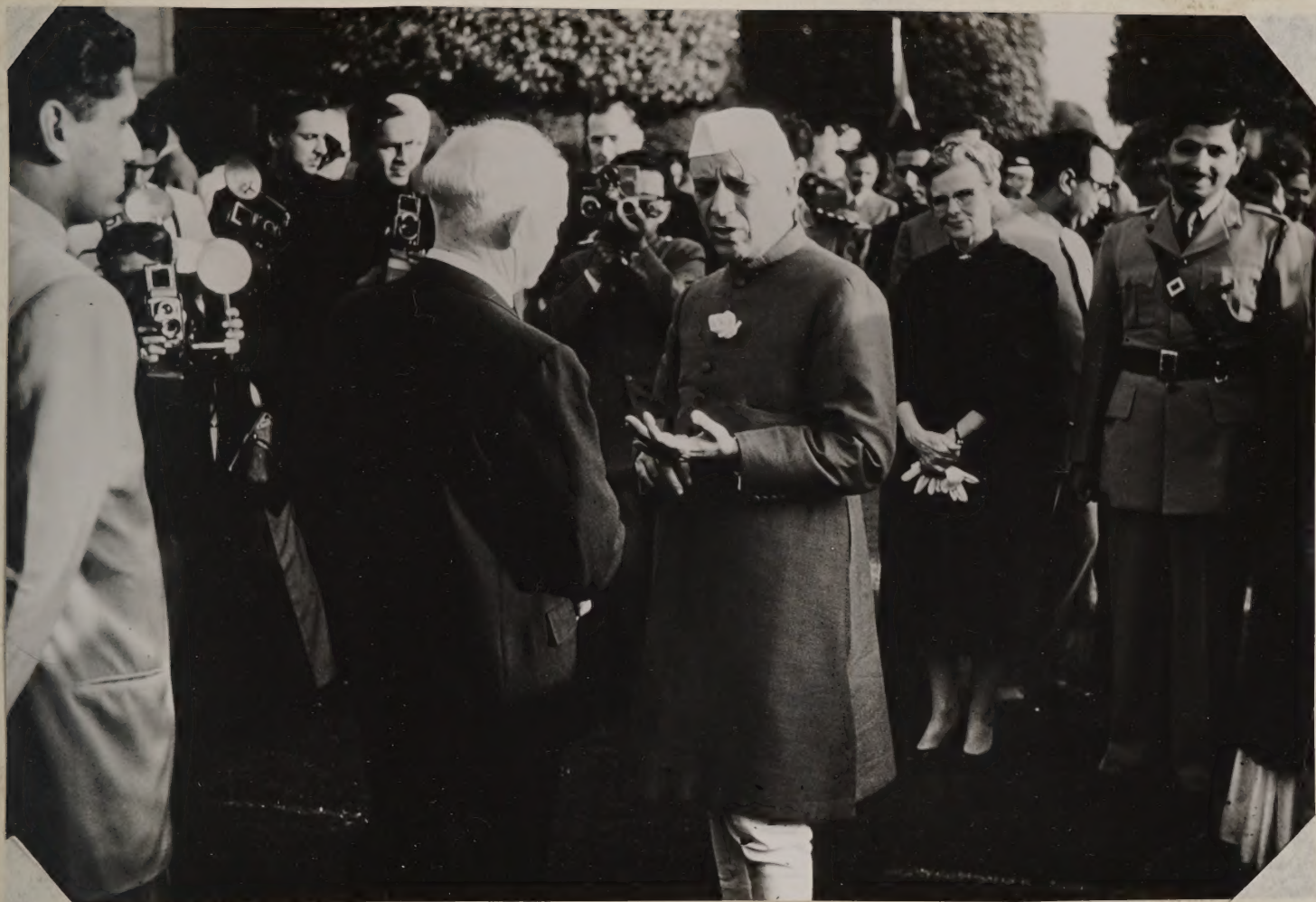
K-2493. At the President's reception in Delhi. The President, Mr. Rajendra Prasad, wears a white cap.

8.6

K-2493. At the President's reception in Delhi. The President, Mr. Rajendra Prasad, wears a white cap.



Dr. C. E. Kellogg



K-2494. At the President's reception in Delhi. Mr. Jawaharlal Nehru, the Prime Minister, wears a yellow rose on his coat.

B. EXIT.

As cars will be parked near the main gate of entry, ladies and gentlemen are requested to kindly use the same route for Exit.

By order,

RASHTRAPATI BHAVAN,
NEW DELHI,
January, 1958.

HANMADAN SINGH,
Major-General,
Military Secretary to the President

8.7

At the President's reception in Delhi. Mr. Jawaharlal Nehru, the Prime Minister, wears a yellow rose on his coat.



X-1

Dr. C.E. Kellogg

presence is requested at the

Republic Day Parade

26th January 1958 (6 Magha 1879)

The President will take the Salute.

Please turn over.

NOTICE.

A. ENTRANCE.

(i) Guests are requested to bring the enclosed Invitation Card with them which may please be shown at the point of Entry.

(ii) Guests are also requested not to bring children or friends.

B. EXIT.

As cars will be parked near the route of entry, ladies and gentlemen are requested to kindly use the same route for Exit.

By order,

RASHTRAPATI BHAVAN,
NEW DELHI,
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Major-General,
Military Secretary to the President.

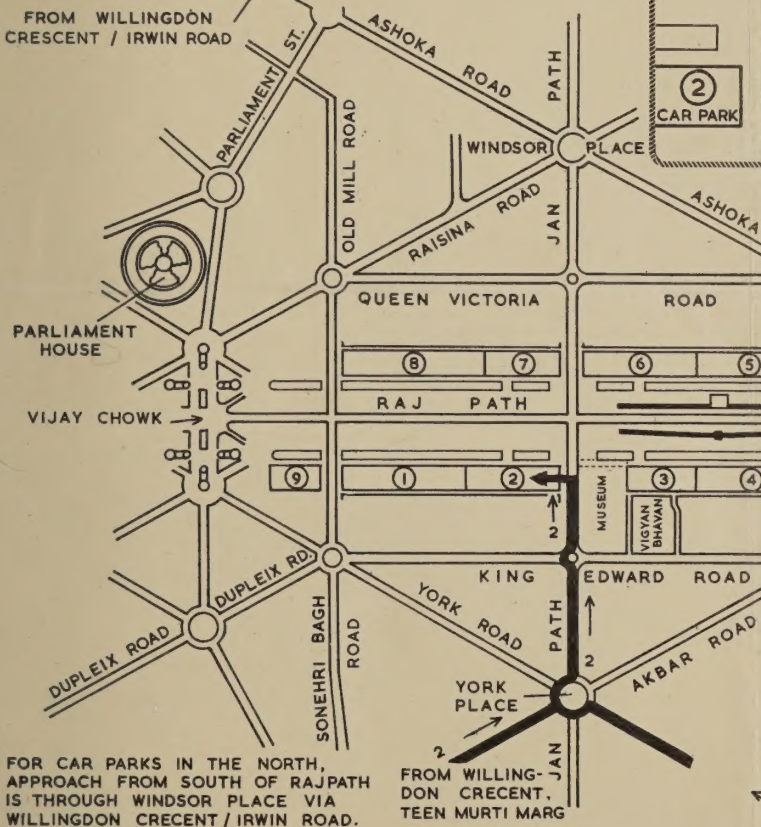
1958

Republic Day Parade

GUIDE MAP FOR CAR PARK ROUTE No. ②

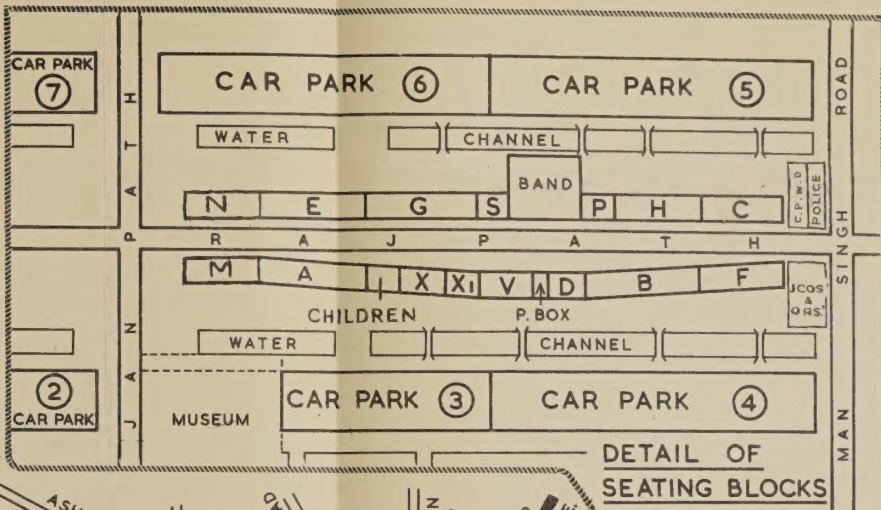
FOR DESCRIPTION PLEASE SEE
REVERSE OF CAR PARK LABEL

FROM WILLINGDON
CRESCENT / IRWIN ROAD



FOR CAR PARKS IN THE NORTH,
APPROACH FROM SOUTH OF RAJPATH
IS THROUGH WINDSOR PLACE VIA
WILLINGDON CRESCENT / IRWIN ROAD.

FROM WILLING-
DON CRESCENT,
TEEN MURTI MARG



REFERENCE

- ① YELLOW CAR PARK
- ② PINK CAR PARK
- ③ RED CAR PARK
- ④ BLUE CAR PARK
- ⑤ GREEN CAR PARK
- ⑥ WHITE CAR PARK
- ⑦ BROWN CAR PARK
- ⑧ & ⑨ PUBLIC CAR PARKS

9-30 A.M. *The President arrives in State.*

The Prime Minister receives the President.

The National Flag is broken at the mast and the President's Body Guard and the massed bands give the National Salute.* Simultaneously a 31 guns salute is fired.

The Prime Minister introduces the Defence Minister, Deputy Defence Ministers and the three Chiefs of Staff to the President and then escorts him to the dais.

The investiture for Ashoka Chakra Class I awards. The next-of-kin of late Lt. Col. Jagannath Raoji Chitnis, 2/Lt. Polur Muthuswamy Raman and Havildar Joginder Singh are in turn presented to the President. The respective citations for the awards are read and the President presents the gallantry decorations posthumously to the next-of-kin.

9-42 A.M. *The Republic Day Parade (Order of March given on the opposite page).*

10-40 A.M. *The pagentry procession.*

Shehnai and Dhause on elephants.

A Cavalcade of Tableaux.

School Children.

Folk Dancers.

Industrial Workers and Peasants

11-29 A.M. *Fly-Past by aircraft of the Air Force (Order of Fly-Past on the last page).*

*National Salute.**

11-40 A.M. *The President departs in State.*

The Vice-President, the Prime Minister, Ministers and Members of the Diplomatic Corp depart.

Other Guests depart.

** Guests are requested to stand, and officers in uniform to salute.*

ORDER OF MARCH

The Parade Commander The Armoured Corps Light Tanks (Stuarts) Light Tanks (AMX 13) Medium Tanks (Shermans) Heavy Tanks (Centurians) The Regiment of Artillery Self Propelled Guns Field Guns Heavy Mortar Guns Medium Guns Heavy Anti-Aircraft Guns Light Anti-Aircraft Guns The Corps of Signals (Specialist Vehicles) The Army Service Corps (Transport Vehicles) Amphibian Vehicles The Corps of Electrical & Mechanical Engineers (Specialist Vehicles) Horsed Cavalry Ganga Jaisalmer Risala Gentlemen Cadets The Engineers Band (Bombay Engineer Group) Corps of Engineers The Brigade of Guards The Parachute Brigade Pipes and Drums of the Punjab Regiment The Punjab Regiment The Madras Regiment Pipes and Drums of the Grenadiers The Grenadiers The Mahratta Light Infantry Brass Band of the Rajputana Rifles The Rajputana Rifles The Rajput Regiment The Jat Regiment Pipes and Drums of the Sikh Regiment The Sikh Regiment The Dogra Regiment	Pipes and Drums of the Gorkha Rifles Regimental Centre The Garhwal Rifles The Kumaon Regiment The Assam Regiment The Sikh Light Infantry Pipes and Drums of the Madras Regimental Centre The Bihar Regiment The Mahar (Machine Gun) Regiment The Gorkha Rifles Jammu & Kashmir Infantry Brass Band of the Sikh Regimental Centre The Army Service Corps The Army Medical Corps The Army Ordnance Corps Remounts, Veterinary & Farms Corps Brass Band of the AMC Centre The Army Education Corps The Corps of Military Police Winter Warfare Troops Pipes and Drums of the Guards The Boys Battalion (North) The Gorkha Boys The Assam Rifles Naval Band The Navy Air Force Band The Air Force Air Force Specialist Vehicles The Territorial Army Field Guns Light Anti-Aircraft Guns Pipes and Drums of the Territorial Army Infantry (Territorial) Ministry of Defence Security Corps Ex-Servicemen of the Army, Navy and Air Force St. John Ambulance Brigade & Nursing Division The Delhi Police Band
--	---

P.T.O.

The Police
 Pipes and Drums of the AOC
 Centre & NCC Band
 The National Cadet Corps
 Cadets of the Sea Cadet Corps,
 Bombay
 Lok Sahayak Sena
 Delhi Fire Brigade

Massed Bands
 The Punjab Regimental
 Centre
 The Gorkha Trg. Centre
 The Rajput Regimental
 Centre
 The Garhwal Rifles Regi-
 mental Centre

ORDER OF FLYPAST

Vampires	..	..	..	12
Toofanis	..	..	..	24
Canberras	..	..	..	12
Mysteres	..	..	..	12
Hunters	..	..	..	12
Gnat	..	..	..	1
Toofani	..	..	..	1
				74

ANDHRA PRADESH

phal

etaphal, the fruit which is grown all over Andhra Pradesh and
ten by people both high and low, is the main theme of this
au.

large model of this fruit is displayed against the background
e typical landscape in which it thrives; the tableau also shows
ruit being plucked by Banjara folk who inhabit the area.

ASSAM

Silk Industry

uga is a type of silk produced exclusively in Assam and with-
he aid of the mulberry plant. Over a lakh pounds of raw
silk are produced annually, and the lovely fabrics made of
silk are widely used by Assamese women. The Muga Silk
try is one of the principal cottage industries of the State.

BIHAR

Project and Shramdan

he ultimate triumph of man's determination and his spirit of
elp is the theme of this tableau, which shows the taming of
osi—the 'River of Sorrow', disastrous on account of its chang-
ourse. Government's appeal for people's help in the project
ad a great response. Thousands of people of all walks of life
red together to contribute their mite in the shape of Shram-
or the construction of large earthen dams along the river.

BOMBAY

a Project

ombay State depicts on the tableau one of its "new temples",
ighty hydro-electric project at Koyna which will feed power-
y parts of Maharashtra, industrialize them and vastly amelio-
he conditions of the people there.

his 39 crore project (1st stage) is shown to scale at the back
e float. The goddess of prosperity is seen in the lotus, offering
blessings to the people. In the fore-ground are seen the

urbanized and electrified area and industrial undertakings. All
round the tableau are colourful paintings highlighting the agri-
cultural and industrial achievements of the State.

HIMACHAL PRADESH

Shepherd Life

With about 13 lakh sheep and goats in Himachal Pradesh yield-
ing nearly as many pounds of wool annually, the rearing of these
animals, not to mention cattle, is of great importance in this moun-
tain State. Shepherds form the backbone of the major cottage in-
dustry of the State. The *pattoos*, *gudmas*, shawls, blankets and
other woollen cloth produced by the craftsmen of the State find a
good market all over the country.

The tableau shows a quiet pastoral scene with sheep, shepherds
and spinners.

JAMMU & KASHMIR

Winter in Kashmir

Winter in Kashmir has through the ages been a source of
inspiration to poets and artists. This tableau shows mountains and
pine-trees covered with snow. The human element is provided by
two Kashmiris preparing tea.

KERALA

Coir Industry

Coir is the fibre of the coconut and Kerala is the world's chief
prodacer of coir and its products. The yearly output from this
State is nearly 1,30,000 tons, and more than half of it is exported,
earning nearly a hundred million rupees in foreign exchange. The
coir industry plays an important role in the economic life of the
State as it employs more than 6,00,000 workers.

This colourful tableau shows stages in coir production and some
of the products.

MADHYA PRADESH

Sanchi Stupa

This tableau from Madhya Pradesh represents the famous stupa
at Sanchi, an eloquent tribute to the great Buddha, and his message
of love and peace.

Included in the tableau are a few *Bhikkus* dressed in traditional
robes and carrying begging bowls in their hands. At one extrem-
ity is a model of the famous Sanchi Gate.

MADRAS

Navarathri Kolu

The tableau from Madras depicts the Navarathri festival cele-
brated in South India for nine days during September-October.

Dolls representing gods, goddesses, human beings and all kinds
of animate objects are exhibited on a gallery-like stage. Though
principally a festival for women and children, the occasion is avail-
ed of to invite relations, friends and neighbours to the "show". At
this social gathering fruits and flowers are distributed to the guests,
and the celebrations come to an end with puja being offered to
Saraswati, the Goddess of Learning.

MANIPUR

Fishing Girls

The central theme of this tableau from Manipur is legend on
the origin of fishing among the rural people near Lokhtak Lake.

A legendary figure was killed by his son and the body was thrown
in a pond. The mother went down with her companions to search
for the body and that was the origin of the net-fishing.

Fishing with nets as well as with ropes is attempted to be
portrayed in the tableau.

MYSORE

The Khedda

The Khedda is an operation to round up wild elephants as a
means of checking the increase of their population. Started in
1873, this operation, which is a speciality of Mysore State and has
won wide renown, has been carried out 32 times so far leading to
the capture of 1,652 elephants.

In a khedda, herds of elephants are trapped in the forest and
driven into an area surrounded by a deep ditch. They are then
shepherded in twos or threes into a special stockade of bamboo
and wood. The elephants so captured are then 'roped' inside the
stockade.

The tableau depicts the roping of a tusker with the aid of two
tame elephants against the background of a stockade.

NORTH-EAST FRONTIER AGENCY

Adi Girls

The theme of this tableau from NEFA is taken from certain
dances performed by Adis, one of the Naga clans, during some of
their religious festivities.

It shows a group of Adi girls in a circle with their leader, called
Miri, standing in the centre singing and jingling his sword. As they
do in a dance, the participants move gracefully changing their
formation from time to time.

ORISSA

Kalinga Ships

This tableau from Orissa depicts the ancient ceremony of 'Boita
Bandana', which used to be performed when boats set out on long
voyages from the coast of Orissa, then known as Kalinga.

In the maritime history of India, Kalinga is associated with the
prosperous and flourishing era when sea-trade with far-off lands like
Java, Sumatra, China and Ceylon flourished. Usually 'Boita
Bandana' was performed after the monsoon when ships sailed
out into the sea. Today, it has become an important festival in
every Oriya home. On this occasion Oriyas set afloat, in rivers and
tanks, boats made either of paper or the bark of banana trees. The
womenfolk draw figures, in their courtyards, of boats laden with
cargo and place their jewellery and other valuables over them.

The river-craft used in this tableau recalls the boats in vogue in
the glorious days of Kalinga.

THE PUNJAB

Kulu, The Happy Valley

Described as the Valley of the Gods, Kulu, in the Punjab, is the
central theme of this tableau. Because of its enchanting surround-
ings, salubrious climate and, above all, scenic grandeur, this valley
has become a popular tourist attraction.

An effort has been made to portray the spirit of calm and quiet
pervading the valley. This spirit is reflected in the simple life
led by its inhabitants and their quaint customs and traditions.

RAJASTHAN

Our Rajasthan

A glimpse of Rajputana, whose people, though differing in
music and language from place to place, are all knit together by a
common culture which has been preserved through the ages.

The tableau presents specimens of some of Rajasthan's famous
landmarks, like the Victory Tower of Chittor and the Hawa Mahal
(Wind Palace) of Jaipur and the Bundi Gates. Similarly, gay and
colourful costumes which are typical of the State are displayed by
the men and women on the tableau.

UTTAR PRADESH

Unity in Diversity

Unity, which has sustained life in India through the ages notwithstanding its diversities, religious, social and cultural, is the theme of this tableau from Uttar Pradesh.

It depicts Emperor Akbar having a discussion with learned men of his time in his palace at Fatehpur Sikri. It also shows a glimpse of the famous gate at the same place, known as Buland Darwaza. The girls seated on the globe represent different nationalities, and their outstretched hands portray the everlasting human desire to exist in peace and prosperity.

WEST BENGAL

Cottage Industries

In West Bengal about a million people are dependent on small scale industries for their living and the total value of their annual output is estimated at Rs. 44½ crores. Some of the well-known handicrafts of the State such as handloom, fabrics, ivory carvings, dolls and toys, bamboo work and sea-shell and conch-shell carvings are artistically displayed on this tableau from that State.

MINISTRY OF FOOD & AGRICULTURE

(INDIAN COUNCIL OF AGRICULTURAL RESEARCH)

Vegetables

Rich in vitamins and minerals essential for maintaining good health, vegetables have formed the main ingredient of food in India. Recent discoveries suggest that vegetables, if properly used, even help develop a clear soft skin and bright eyes better than any cosmetics.

With its varied climatic and soil conditions India grows a large variety of vegetables and, with proper care, the yield per acre can be increased. The striking design of the tableau is intended to bring vegetables to the forefront of the peoples' minds.

MINISTRY OF RAILWAYS

Chittaranjan Locomotive Works

The role played by the Locomotive Works, Chittaranjan, situated about 140 miles from Calcutta, in helping the Indian Railways is well-known. The factory was set up to make the country self-sufficient in steam locomotives and has cost nearly Rs. 15 crores.

Until the end of last year, *i.e.*, within a period of seven years, 611 locomotives had come out of these works. About 5,000 workers are employed in them; they also produce over 80 per cent. of the components required in the production of a locomotive.

The factory is at present turning out 14 broad-gauge locomotives of the WG type per month.

TATA IRON AND STEEL COMPANY

Fifty Years of Indian Steel

This tableau prepared by the Tata Iron and Steel Company depicts the role played by steel in the industrial development of the country. The float shows a blooming mill in the shape of a giant, disgorging "blooms"—long pieces of steel. An attempt is made to create the atmosphere of the mill, clangorous and red hot, through the sights and grounds of the tableau. The typical steel-plant costumes are modelled by the children, who pose as the workers of the mill. On its either side, the float carries pictures concerning the industry.

CENTRAL PUBLIC WORKS DEPARTMENT

(Directorate of Horticulture)

Flowers

Not only in India but practically all over the world, flowers have played an important part in our daily life. They bring beauty and fragrance to our activity throughout life and are with us to our very end. No ritual, no festival and no gathering social or religious can be complete without flowers.

In the preparation of this tableau different varieties of flowers have been used. The fountain symbolises Life for, without water, life whether human or plant, cannot exist. A large variety of flowers have been artistically arranged in different patterns *en masse*.



CULTURAL PAGEANT



PRINTED BY THE MANAGER GOVT. OF INDIA PHOTO-LITHO PRESS, NEW DELHI

JANUARY 26, 1958
MAGHA 6, 1879 (SAKA)

both sides of the long avenue. Unhappily, I have little experience in estimating crowds. This one is certainly more than one million people, perhaps considerably more. This great avenue, Raj Path (formerly called King's Way) extends as far as I can see through the morning haze. Although bright and sunny the air is fairly misty.

We are in our seats at 8 a.m. Mr. Nehru walks by and greets people about 9 o'clock and the parade is to begin at 9:30. Copters fly over the avenue throwing colored paper onto the crowd. They fly dangerously low. The crowd is in a good mood, the air is like a lovely day in May at home. The program is started by the President of India and the playing of the national anthem. This is followed by a speech partly in English and partly in Hindi.

The parade begins with the military including tanks, guns, and other equipment all freshly painted and with bright red and white here and there to break the monotony of the khaki brown. Then comes the camel cavalcade and many kinds of foot soldiers in dress uniform. Some of these are very colorful indeed. The nurses march by in uniform; there follow a series of cloats from each of the States; many large groups of youth; and finally groups of dancers.

We leave just a bit early as the jet fighters zoom overhead. This is the most interesting parade I have ever seen except for the great Victory Day parade in the Red Square in Moskow in 1945.

Just as we leave the hotel there is a hard tropical shower, which is said to be unusual at this time of year.

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PLEASE KEEP THIS ADDRESS WITH YOU !

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LABH SINGH

SCIENTIFIC MASSEUR

**of the 1st Asian Games held in New Delhi, 1951
Masseur to the Second Asian Games**

ATHLETES OF INDIA 1954

**Masseur to 1st Russian Football Test held at
New Delhi in 1955**

**Masseur to C-in-C's Football Team v/s. Russians
New Delhi, 1955**

Ex-Masseur and Boxing Instructor of

BRITISH ARMY

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care of CHAWLA STORES

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Phone : 44009

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I am back to the hotel at 12 and have lunch with Mr. and Mrs. M. L. Wilson, followed by a good long talk about our many common interests. He now tells me that the planning commission assumes that the population will increase from 365 million to 700 million by the year 2000. I then spend the rest of the afternoon on my draft report.

In the evening I have dinner with Mr. and Mrs. Wilson and Dr. Moseman which is followed by another long talk about India.

January 27: To save time I have breakfast in my room and except for lunch and dinner work all day on the draft report and other reports and statements.

January 28: I work on my report until 11:00 a.m. and then find that the typist has done little with all I dictated to him yesterday.

I steal a few minutes and take a cab to look in the book stores but find nothing I want except for a road map and a notebook.

I have lunch again with the Wilsons, do some more work on the report and am ready to go shopping with Mrs. Parker and Mrs. Engle.

I buy some brass things for my folks, which the Parkers will bring with their baggage next June or July.

In the evening Dr. Moseman and I go for dinner chez Lyman Dean. Just as we leave the hotel there is a hard tropical shower, which is said to be unusual at this time of year.

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I have lunch with Mr. and Mrs. Wilson and Mr. Nath of the Planning Commission. He seems to be a very bright young man and would be a good man in India or elsewhere. He suggests that I emphasize the great importance of better salaries for agricultural scientists and also that the young men must be promoted somewhat more rapidly than they are at present if they are to be attracted to the work.

After lunch I nearly conclude a first draft of my report, which Mr. Nixon reads in my room. At 5:15 I go to tea arranged in my honor by an old acquaintance, Dr. J. N. Mukherjee. I knew him from conferences in Britain. He is now on the Indian Public Service Commission. (I am told by some that he has gotten to be quite dictatorial and arbitrary in his decisions). Then Dr. Cummings drives me to his home and after a few minutes he, Mrs. Cummings, and I go to a cocktail party at the home of Mr. C. R. Eskildsen, United States Agricultural Attache in India.

We leave about 8:15 and go to the home of Mr. Acharya, Head of the FAO Regional Office in India, for dinner. He had also been

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January 30: I am up early in order to put some final items in the report for K. V. Ramswami, Dr. Cummings' secretary to type, and arrange for 3 corrected draft copies. Of course this is only a draft that I expect to modify considerably after my next field trip.

With Dr. Basu and Dr. Cummings I visit Dr. Raychaudhuri at the Institute. Here we discuss some of the problems of soil survey organization and I advise strongly against adding a forester, agronomist, and engineer to the Soil Survey staff.

Dr. Basu talks about the fine work in Bombay State. Here too the work is supported by 25 percent subsidy and 75 percent by the cultivators to be repaid in 15 installments with 4 percent interest.

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Mrs. Cummings takes me to the art shop of Kashmir. I had in mind perhaps to buy a rug. They have some nice rugs but the prices seem quite high to me and I have learned that it is expensive to ship things from India. I do buy some little papier-mache boxes and small bowls.

Back at the hotel I have a conference with Mr. Satwani Singh, a farmer member of the Indian Research Agricultural Council from the Uttar Pradesh. Then I go to dinner with him, Mr. and Mrs. M. L. Wilson, and Mr. and Mrs. Hurt from Lahore in Pakistan.

Now I again arpack and take all of my extra things down to the Rockefeller Foundation office. I certainly hope no one breaks into this place because I have packed away some jewels for my wife.

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January 31: I am up at 5:45 and have breakfast in the room.

At 6:45 Dr. Cummings and Dr. Basu take me to the airport. It turns out that we arrive somewhat earlier than necessary and we have a long wait in a very cold airport. Dr. Basu has with him his secretary, Mr. Khullar, for whom I see no need, but I suppose it is partly a matter of prestige.

About 8 o'clock we get on the plane, and then we are told to go back into the station for awhile. I have some more tea and return to the plane. We take off for Bombay at 8:45.

Dr. Basu talks almost continuously and shows me many papers he has brought along. He then introduces me to a maharaja on the plane - a Mr. Yadavindra Singh. He has a large farm in the Punjab and is a neighbor of Satawani Singh with whom I spoke the other evening. The maharaja is a big fellow about 6 feet, 4 inches tall. He is very keen on farming and says he uses only tractors for power. He grows citrus, wheat, and pulses. Besides he has some orchards of pome fruits in the hills further north.

I get little chance to see anything out of the plane. Near Surat the land appears to be thinly populated. Near that place we have to curve out to sea around a small Portuguese area called Daman, which lies north of the main Portuguese spot of Goa. These small holdings Portugal insists upon keeping are very sore spots to the Indians. This place Daman doesn't seem to be very thickly populated. I see some areas for the evaporation of salt.

January 31: I am up at 5:45 and have breakfast in the room.

At 6:45 Dr. Cummings and Dr. Basu take me to the airport. It

turns out that we arrive somewhat earlier than necessary and

we have a long wait in a very cold airport. Dr. Basu has with

him his secretary, Mr. Khulnar, for whom I see no need, but I

suppose it is partly a matter of prestige.

About 8 o'clock we get on the plane, and then we are told

to go back into the station for awhile. I have some more tea

and return to the plane. We take off for Bombay at 8:45.

Dr. Basu talks almost continuously and shows me many papers

he has brought along. He then introduces me to a maharaja on

the plane - a Mr. Yadvindra Singh. He has a large farm in the

Punjab and is a neighbor of Satwant Singh with whom I spoke the

other evening. The maharaja is a big fellow about 6 feet, 4 inches

tall. He is very keen on farming and says he uses only tractors

for power. He grows citrus, wheat, and pulses. Besides he has

some orchards of pome fruit in the hills further north.

I get little chance to see anything out of the plane. Near

Surat the land appears to be thinly populated. Near that place

we have to curve out to sea around a small Portuguese area called

Daman, which lies north of the main Portuguese spot of Goa. These

small holdings Portugal insists upon keeping are very sore spots

to the Indians. This place Daman doesn't seem to be very thickly

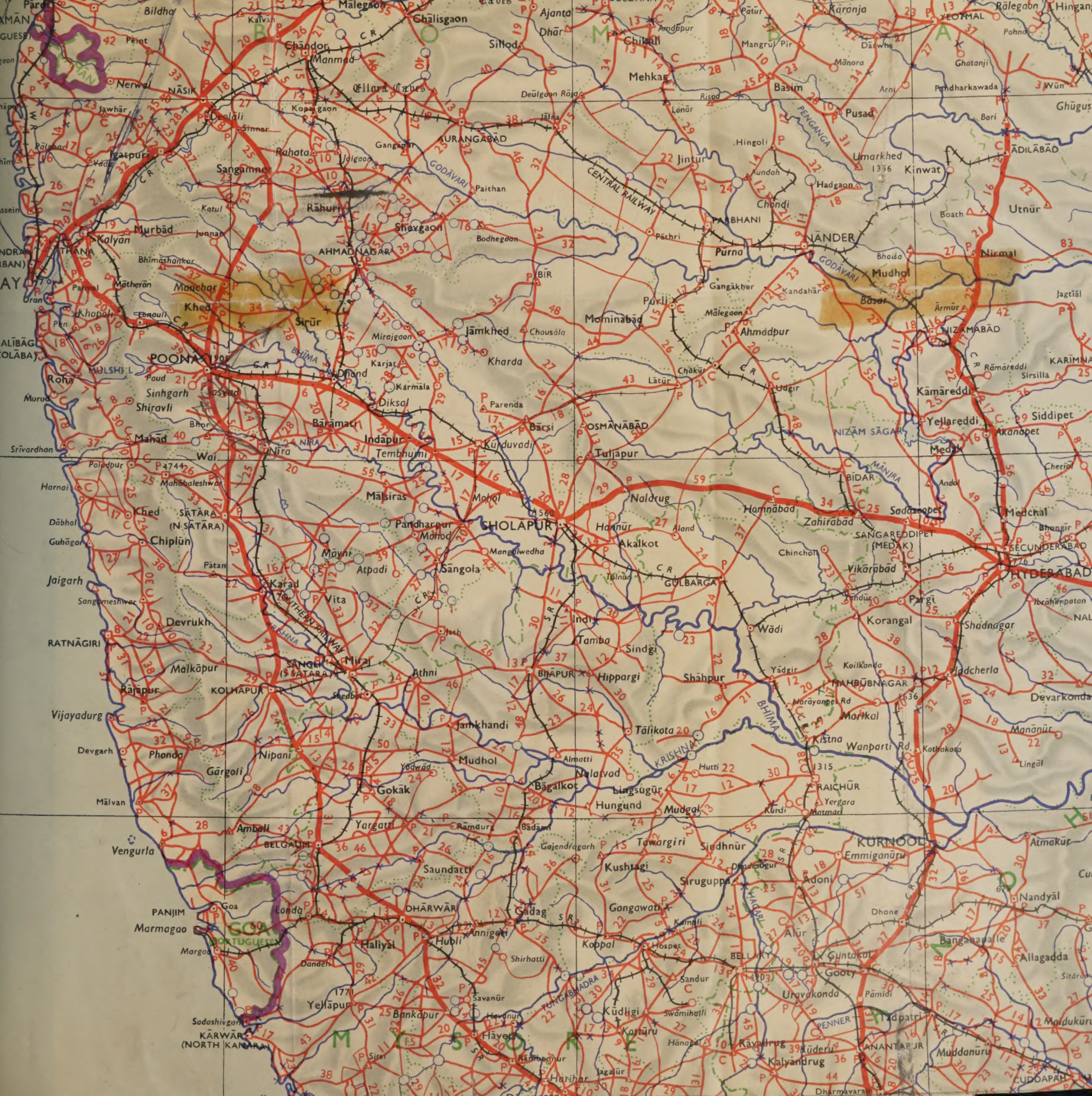
populated. I see some areas for the evaporation of salt.

As we go on there are many low, steep, irregular nearly barren hills. The closer we approach Bombay the more dense the population. Especially along the coast and near the rivers I see many salty areas on the high terraces along the streams. The sea under the plane is grayish brown, probably from the material brought into it from the numerous rivers.

We are down in Bombay at 11:30 and are met by Dr. A. N. Puri. We are to have lunch at his house along with the Secretary of Agriculture and Forestry for Bombay State, Mr. Sathe. We drive out in very hot, sunny crowded streets. First I am taken to Puri's laboratory, which he says he can support with his own private funds from a cork business and an adhesive business. Then he tells me also he owns apartments that he rents. But most of the staff are paid from government funds. He shows me bulletins that he issues on the analyses of surface soil samples sent to him by agricultural chemists all over India. But he has no descriptions of these and two few facts about them to make the results meaningful.

Dr. Puri talks a stream, telling me his ideas, which represent his imperfect understanding of results published by others long ago. He is a curious mixture of extreme conceit, shrewdness, mystery, and pure boloney.

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Bombay
Trip



Then we go to lunch chez Puri with the Secretary of Agriculture and Dr. Puri's wife, daughter, and son-in-law. The wife is his second one, a German. I find the family and the Secretary very charming and Puri says little at home.

After lunch we drive into the city where I look in some shops for a few moments but buy nothing. We go along the Marine Drive near the sea. This street could almost pass for one in Miami, Florida. Then we go through crowded streets to the railway station where I board the train for Poona with Dr. Basu and Mr. Khullar.

As we leave the suburbs of Bombay we are on the hilly edge of the plateau of trap rock. These low mountains are called the Western Ghats. The soils are dark brown thin and clayey. The lithosolic soils on the slope are stony. They have a well-developed mezzo-relief. In small low places and along the small streams the soil is banded for paddy.

I am told that "rabbing," a poor practice, is common here. The cultivators burn the stubble on a small plot of land for growing rice seedlings. These are later transplanted. The cultivators think that this burning of the stubble helps to improve soil structure.

As we gradually climb on the railway, the valley widens. The stream along the bottom is trenched from 12 to 15 feet.

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As we gradually climb on the railway, the valley widens. The stream along the bottom is trenched from 12 to 15 feet.

Soil depth above the rock varies from a few inches to several feet. Some of the wasteland or scrub pasture could be used in small fields for chick peas and similar crops.

The cultivators here have many stacks of rice straw within the villages on top of 6- to 10-foot platforms.

We pass Neral, 54 miles from Bombay, and start another long climb to get onto the plateau. Here there are many small paddy fields and rough grazing on bumpy, stony soil. In some of the paddy fields, chick peas have been sown in the rice stubble. As we go up very slightly, the valley broadens, the surface soil becomes darker, and higher proportion of the soil is in paddy. I see the sharp curves of the edge of the plateau just ahead. The strata in the trap rock show clearly in the twilight.

We pass Jarkat. The rainfall here within the so-called Western Ghats is said to be 100 inches and more.

Dr. Basu tells me that for the wetland paddy the soil is thoroughly puddled and one-month-old rice seedlings put out. Although this puddling ruins the structure, he says that it helps to hold water.

As we pass through the gorge in the high escarpment, daylight changes to darkness. And I wonder why I take trips like this so far away.

We arrive at Poona about 8:30 p.m. Many people are sitting or lying on the platform.

Soil depth above the rock varies from a few inches to several feet. Some of the wasteland or scrub pasture could be used in small fields for chick peas and similar crops.

The cultivators here have many stacks of rice straw with- in the villages on top of 6- to 10-foot platforms.

We pass Neral, 24 miles from Bombay, and start another long climb to get onto the plateau. Here there are many small paddy

fields and rough grazing on bumpy, stony soil. In some of the paddy fields, chick peas have been sown in the rice stubble.

As we go up very slightly, the valley broadens, the surface soil becomes darker, and higher proportion of the soil is in paddy. I see the sharp curves of the edge of the plateau just ahead.

The strata in the trap rock show clearly in the twilight.

We pass Jarkat. The rainfall here within the so-called

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Several meet us as follows:

Mr. D. H. Gokhale, Deputy Director of Agriculture (Engineering)

Dr. M. M. Kibbe, Soil physicist in the Government of Bombay State

Dr. B. B. Roy, Soil Correlator for the Black Soils

Mr. D. G. Kelkar, Divisional Soil Conservation Officer at Baroda

Mr. G. S. Puri, Botanical Survey

Mr. J. Vasavada, Botanical Survey

I am told that there is 27 inches of rain at Poona.

I am taken by jeep to the Poona Hotel, for a light dinner and

I am early to bed.

February 1: I am up at 6:10 for early tea and breakfast and we

leave at 7:30 on a nice clear morning with haze for a field trip

northeast of Poona to the village of Parnel. (A clear morning

with haze may sound strange. The sky is clear if one looks straight up, but very hazy if one looks horizontally.)

We pass the Mutha River. At the edge of the city the soils are called "medium black" and are about 6 to 18 inches over the trap rock.

I am told that in the conservation work here they no longer try to work with individual cultivators but favor the organization of a "farmers' union," a kind of cooperative, and take at least a whole village, which amounts to about 2,000 acres or more. Normally the bunding costs 40 rupees per acre of which the cultivators pay 75 percent in 15 annual payments. This cost includes the time of these soils were deeper and that they have been injured by accelerated erosion.

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I am told that in the conservation work here they no longer try to work with individual cultivators but favor the organization of a "farmers' union," a kind of cooperative, and take at least a whole village, which amounts to about 2,000 acres or more. Normally the bunding costs 60 rupees per acre of which the cultivators pay 75 percent in 12 annual payments. This cost includes the time of

the technical staff. I am told their records show about a 35 percent increase in yields from bunding alone except on dry farming for millet where the increase is about 51 percent.

(Added later: Increases at the stations and demonstration farms are much higher). I am also told that in Bombay State, the cultivators are guaranteed against losses. So far the government has not had to pay any appreciable damages. By having the farmers organized within the villages, the farmers have been able to assume part of the responsibility and this has made the program go better than formerly.

Along the road here are also banyan trees, but scraggly ones. It certainly is too dry for these trees and I imagine that they get some unauthorized pruning. Along here this thin soil varies in slope from about 2 to 8 percent. The more sloping parts have a stony surface soil and are used for rough pasture except for small patches. I am told that the rainfall decreases slightly as we go on to the northeast.

Out about 10 miles I see some soil that is somewhat deeper. The surface varies from reddish brown to nearly black. Much of it is now fallowed and will be used for millet and sorghum. Irrigated sugarcane is grown in favored places near wells. Still much of the thin sloping soil is in rough pasture. I am told there are about 8 to 9 million acres of this poor sloping soil in Bombay State, with only small patches now in use. I suspect that at one time these soils were deeper and that they have been injured by accelerated erosion.

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The permeability of the deep black soils is low and graded bunds are necessary, both to conserve water for crops and to prevent erosion. But the so-called, "medium black" soils hardly belong in the group of Tropical Black Clay. On these contour bunds are better.

We pass Lonikland, a village out about $12\frac{1}{2}$ miles. Here there is more medium black soil suitable for dry farming.

We cross the Bhima River, which is cut down about 15 feet or so. On the other side, the soil is deeper and varies in color from dark reddish brown to reddish black. We pass some contour bunding for dry farming and I see patches of irrigated wheat and bananas in favored places.

I photograph some of these contour bunds on the "medium black" soil, which is actually dark reddish brown. The soil is about 9 to 12 inches deep over the weathered and cracked rock. Happily this rock is quite pervious. The slope here is about 2 percent and since the rock is cracked, and the soils thin, I believe that the contour bunds will work. But the graded bunds are better on the more clayey soils with slowly permeable subsoils.

I am told that this bunding has resulted in considerably increased water in the local wells so that many cultivators now have water in their wells for some irrigation through the dry season. This permits the villagers to have some fruits.

K-2445. Feb. 1, 1938. About 60 miles northeast of Poona. Stone facing to protect the end of a contour bund.

The permeability of the deep black soils is low and graded bunds are necessary, both to conserve water for crops and to prevent erosion. But the so-called, "medium black" soils hardly belong in the group of Tropical Black Clay. On these contour bunds are better. We pass Loukiland, a village out about 12 1/2 miles. Here there is more medium black soil suitable for dry farming. We cross the Rhina River, which is cut down about 15 feet or so. On the other side, the soil is deeper and varies in color from dark reddish brown to reddish black. We pass some contour bunding for dry farming and I see patches of irrigated wheat and bananas in favored places. I photograph some of these contour bunds on the "medium black" soil, which is actually dark reddish brown. The soil is about 9 to 12 inches deep over the weathered and cracked rock. Happily this rock is quite pervious. The slope here is about 2 percent and since the rock is cracked, and the soils thin, I believe that the contour bunds will work. But the graded bunds are better on the more clayey soils with slowly permeable subsols. I am told that this bunding has resulted in considerably increased water in the local wells so that many cultivators now have water in their wells for some irrigation through the dry season. This permits the villagers to have some fruits.



K-2444. Feb. 1, 1958. 15 miles northeast of Poona. Contour bund on dark reddish-brown soil - intergrade between Tropical Black Clay and Reddish Brown. Two percent slope and soil about 9 to 12 inches deep over weathered trap. The pits at the right will be smoothed



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K2444

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IV

K2445

K-2445. Feb. 1, 1958. About 60 miles northeast of Poona. Stone facing to protect the end of a contour bund.

I am shown the maps by local technicians at the village of Kondhapur, where bunds were developed on the contour in 1953 and 1954. Just now the outlets are being completed along with the stone facings on the ends of the bunds. I am told that these bunds will hold about 1 foot of water.

I meet the head man of the village, S. B. Gaikwad, who has 52 acres in 11 different plots. All of his land is bunded. He is growing sorghum, sugarcane, chilies, millet, vegetables, and oranges. All but the millet and sorghum are irrigated. He plans to make some gradual changes to peanuts. Buffalos are kept for milk. This village is also an "extension block," where advisory work is concentrated to encourage the cultivators to use better seeds; more fertilizer, especially sulphate of ammonia and peanut cake; medical facilities; milk for the children; and better schools. So far there is no home economics work.

There are no soil surveys here except for soil depth (deep, medium, and shallow) and soil slope by one-foot contours. For this bunding work the deficiency is not too serious because the rocks are quite uniform. But for farm and village planning they should have a soil survey by all means that would indicate the important types since the soils on the terraces are quite different and have significant variations in crop adaptations, especially between the old terraces and the recent ones.

Aug. 1, 1955. Village of Parner, 65 miles northeast of Poona. A new bund under construction. The pits will be smoothed out.

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K-2446. Feb. 1, 1958. At village of Parner, 68 miles northeast of Poona. The village leaders who take responsibility for seeing that the bunds are made. One holds the village map outlining the bunds.



K-2447. Feb. 1, 1958. Village of Parner, 68 miles northeast of Poona. A new bund under construction. The pits will be smoothed out.

It is confusing to call these soils "black." They are too well oxidized. But the research work is so poorly organized, especially the associated laboratory work, that it would be very difficult to get adequate data for precise interpretations. Probably Dr. Puri of Bombay has had a bad influence. Here also samples are taken of only the surface soils with no soil descriptions or descriptions of previous management. Consequently, the results mean nothing in practical terms. As a very minimum there are 5 situations that should be separated: (1) Soils on the uplands; (2) soils on the slopes of the kind that are normally cultivated; (3) old alluvial terraces; (4) young alluvial terraces; and (5) hydromorphic soils on gentle slopes. Some of the soils are reddish brown, some dark reddish brown, some reddish black, and a few black. I note wide differences in crops and yields in these different situations. Even though these differences are not significant to bunding, they are to other phases of soil conservation.

Along here there are a few shrubby trees that resemble the mesquite in Texas. At 50 miles from Poona we turn off the main road to the northeast on an old track.

We pass another village with complete bunding, mostly on alluvial and colluvial surfaces. Here the chief crop is sorghum (jowar). The fodder is fed to the cattle. The village, each man is paid 1½ rupees per day. One man with a pair of bullocks to operate

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We are now approaching Parnel where the rainfall is down to 22 inches. The soils are mostly clayey Reddish Chestnut or Reddish Brown from a base-rich trap. I am told that the income per family of about 5 people is 600 rupees per year. We stop to look briefly at a spot where diploma holders are being trained to make surveys of soil depth and slope. I am told that one man surveys about 10 acres at a scale of 1 inch equals 100 inches with the help of 3 laborers. In most of their regular work the scale is 1 inch equals 220 feet, or 1:2,640. They have here 46 trainees for 6 months.

The soils are shallow, stony, very dark reddish-brown clays from trap. The pH is said to be about 7.5 to 8.5. The sloping soils are quite seriously eroded and so uneven that terracing is scarcely practicable. I am told that without irrigation here they have only one crop per year with an average yield of about 200 pounds of sorghum, with ranges from 110 to 400 pounds. Variations in soil color from red to reddish black are apparently related to differences in the character of the trap rock and moisture in the soil.

We drive on a bit and stop to see new bunding work in progress. We are met by a group of farmers, representing the farmers union in the village, who are responsible for seeing that adequate labor is available. The labor is mainly from the village, each man is paid $1\frac{1}{2}$ rupees per day. One man with a pair of bullocks to operate

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a scraper, which is furnished by the government, pays 3 rupees per day.

The soil here is a very heavy reddish brown soil. There are about 9 inches of dark reddish brown clay loam with a medium granular structure.



Labor is reasonably plentiful and no bulldozers are used.

Most of the soil to make the beds is dug up and carried by hand.
K-2448. Feb. 1, 1958. Village of Parner, 68 miles northeast of Poona. The soil profile here. About 11 inches of dark reddish-brown soil over limy weathered trap.

Scrapers
The cultivators get cash at the time they do the work or they get credit to apply to their part of the cost for the work on their own land.

I am told that the land is taxed at about 1/2 rupee, depending upon its quality. Thirty percent of the taxes remain in the village. The secretary of the committee is a cultivator appointed by the village and he gets 65 rupees per year (?).

IX

K 2448

Stations K-2448. Feb. 1, 1958. Village of Parnar, 68 miles northeast of Poonam. The soil profile here. About 11 inches of dark reddish-brown soil over fine weathered trap.

a scraper, which is furnished by the government, gets 5 rupees per day.

The soil here is a thin clayey reddish brown soil. There are about 8 inches of dark reddish brown clay loam with a medium granular structure A_p over a limy C_1 . The underlying trap seems to have quite a bit of glauconite in it. Although I am told that the trap rock is unusually uniform I doubt that this is so.

We are now in a great hurry and, as usual, very far behind schedule.

We drive into the village and meet in the offices of the village committee or "panchayat." I am extremely pleased to see the way that these conservationists here have given responsibility to the villagers. They speak of the "peoples" program," which it really is.

Labor is reasonably plentiful and no bulldozers are used. Most of the soil to make the bunds is dug up and carried by hand. Scrapers pulled by bullocks are used for some of the big bunds. The cultivators get cash at the time they do the work or they get credit to apply to their part of the cost for the works on their own land.

I am told that the land is taxed at about 1/16 to 3 rupees, depending upon its quality. Thirty percent of the taxes remain in the village. The secretary of the committee is a cultivator appointed by the village and he gets 65 rupees per year (?).

a scraper, which is furnished by the government, gets 2 rupees per day.

The soil here is a thin clayey reddish brown soil. There are about 8 inches of dark reddish brown clay loam with a medium granular structure A_p over a limy C_l . The underlying trap seems to have quite a bit of glauconite in it. Although I am told that the trap rock is unusually uniform I doubt that this is so.

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After this discussion, along with tea, the villagers insist that I go to see their new school. As I leave the council room for the school they throw a garland of flowers around my neck. The school is very neat and clean and they are obviously very proud of it.

We turn back toward Poona at 11:50 a.m. which means 69 miles before lunch. On the way back I notice also a few patches of safflower grown for the oil seeds.

The cultivators in this area are quite poor, but apparently are thrifty. Essentially all of them are barefoot. Generally all of the women and some of the men carry their loads on their heads.

Again I am impressed by the fact that my Indian associates have no concept of time and distance. One never knows when he is being deliberately mislead and when his guides are simply exhibiting unreliable judgment.

Near Poona I stop to take pictures of plowing with a double team of bullocks. The soil on an old alluvial terrace is very dark reddish brown to reddish black. I should say that this soil is closer to Reddish Chestnut than to Tropical Black Clay. I don't believe it suffers seriously from erosion. The land is being prepared for sorghum. It is said that such plowing is to be done only once in 3 years. This plowing does not really turn a furrow. It leaves the whole soil very cloddy. I am told that effort is being made to encourage more seeding without plowing.

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We turn back toward Poona at 11:50 a.m. which means 69 miles before lunch. On the way back I notice also a few patches of self-flower grown for the oil seeds.

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Again I am impressed by the fact that my Indian associates have no concept of time and distance. One never knows when he is being deliverately misled and when his guides are simply exhibiting unreliable judgment.

Near Poona I stop to take pictures of plowing with a double team of bullocks. The soil on an old alluvial terrace is very dark reddish brown to reddish black. I should say that this soil is closer to Reddish Chestnut than to Tropical Black Clay. I don't believe it suffers seriously from erosion. The land is being prepared for sorghum. It is said that such plowing is to be done only once in 3 years. This plowing does not really turn a furrow. It leaves the whole soil very cloddy. I am told that effort is being made to encourage more seeding without plowing.



K-2449. Feb. 1, 1958. Few miles northeast of Poona. Plowing the clayey, very dark reddish-brown, soil - as intergrade between Reddish Chestnut and Tropical Black Clay. This improved plow does not turn the soil much.



K-2450. Feb. 1, 1958. Few miles northeast of Poona. Same as above, except another view.

IX

94449

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6-2

IX

94450

K-2450. Feb. 1, 1958. Few miles northeast of Poona. Same as above, except another view.

We finally return to the hotel about 2:00 p.m. and have lunch.

I am very glad to have seen the work in this village of



K-2495. Northeast of Poona. Winnowing the jowar, a sorghum.

Director tries to tell that the council and the "jain" school are entirely separate but they obviously weren't in the village I just visited.

He tells me that they are planning to train 1000 a school graduate per year. They also employ diploma holders from the agricultural schools and college graduates with B.Sc. degrees.

K-2495. Northeast of Poona. Winnowing the tower, a sorghum.

11.3

K

We finally return to the hotel about 2:00 p.m. and have lunch.

I am very glad to have seen the work in this village of Parnel with emphasis upon local responsibility and close cooperation with the extension program. But the soil conservationists here have too narrow a view of soil conservation. They think almost entirely of bunding for erosion control, with incidental thought to water control, and a little to fertilizers. They need to consider kinds of adapted crops, yields, and then many other management practices besides bunding.

I am now taken to meet the Director of Agriculture for Bombay State, Captain Mohite. He tells me that Bombay State has 120 million acres, 65 million of which are under cultivation. He emphasizes the importance of the "farmer's union" but I find it a bit hard to get a clear concept of just what it is. Apparently it is partly private and partly government and not officially connected with the village council (panchayat), although apparently the same people are leaders in both. The director tries to tell that the council and the "farmers' union" are entirely separate but they obviously weren't in the villages I just visited.

He tells me that they are planning to train 600 high school graduates per year. They also employ diploma holders from the agricultural schools and college graduates with B.Sc. degrees.

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He tells me 1,200,000 acres have been bunded and that the work is needed on 45 million acres more. He indicates that 30 years to complete the job is the best that can be hoped for. I can hardly agree with that.

I ask him about the extension work and he says that sanitation is the main thing that concerns the home. Families are given some instruction in food nutrients but he says they have very little of what is included as home demonstration work in the United States.

The director has a rather narrow view of soil conservation, as including mainly gully plugging and the building of bunds. I try to convince him of a broader concept but I doubt that I am very successful.

After this call, which is finished with tea, I am taken to the Poona Agricultural College. I meet the principal, L. S. S. Kumar, who takes me about to see an elaborate outdoor exhibit that has just been established for the occasion of the Golden Jubilee of the college. Each college department has a rather nice exhibit. Unhappily, soil science is scattered among chemistry, agronomy, microbiology, a special exhibit on soil conservation, and special crop exhibits of sugarcane, cotton, and the like.

In the agricultural engineering exhibit I see an interesting device consisting of a basic iron frame on rubber-tired wheels to be pulled by bullocks and to which may be attached various kinds of harrows and cultivators. This looks like a promising innovation but it has not yet been field tested.

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In the school they have about 350 students working for B.Sc. degrees. The cost is about 100 rupees per month. Only village boys with scholarships or other outside help could hope to attend.

I am back to the hotel at 6:15 and very tired indeed.

Certainly this area has had a great deal of erosion because of the long dry season and the sharp, heavy rains. I suspect that the hilly areas above 5 to 8 percent slope never did have very much soil; but I suspect that the gentle slopes of around $1\frac{1}{2}$ to 3 percent had up to 3 feet of soil, of which a good deal has been washed away. At the same time the stony valley lands have been gaining in soil depth. As a start the emphasis here on bunding is rightly placed but it needs to be followed by other practices, including better seeds and fertilization, to be truly effective.

While waiting for dinner I am visited by Mr. M. B. Purenik, a soil surveyor attached to the State government. He says that he is making a "soil conservation survey" for the Koyna project about 50 miles west of Poona. This is a hydroelectric project and the object is to plan conservation, including resettlement out of the pool area. The boy is badly mixed up. First he tells me that he has only one kind of "laterite" soil. But then he goes on to say that some parts have hard laterite and some do not! The area gets 200 inches of rain and is mountainous. He tells me that about 40 percent is forest, about 50 percent cultivated, and about 10 percent waste. He is trying to map soil depth,

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slope ranges, state of erosion, and 3 classes of soil capability 4, 5, and 6 - of a general scheme. He collects surface soil samples, some 0-3 inches and some 0-9 inches. In almost the same breath that he explains sampling the surface soils and ignoring the substrata, he tells me the soils have laterite and are very permeable. He has run tests on the physical properties of the surface soils but I don't know just what these show.

He is mapping these individual factors on a scale of 2 inches equal 1 mile. He explains that he and his assistant observe the soils within circles equal to $1/5$ of a square mile at 1-mile intervals, but that they do not draw boundaries over the whole map.

I feel rather sorry for this boy because he has really no idea of what should be done. He is omitting some of the most important soil characteristics and trying to map those that cannot be mapped in a hilly complex. He has no concept of geomorphology, stone lines, the genesis of laterite, and other basic principles.

So far no nutrient tests have been made and no work has been initiated with cultivators. He tells me that most of the area is under shifting cultivation. There are only a few permanent fields with properly prepared bunds.

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I leave Bombay State by train he thrusts a whole sheet of them in my hand. Later in the hotel I write out the answers with references. But I am sure it won't be enough to help him become a soil scientist!)

A late dinner and then to bed.

February 2: The bearer brings me tea at 5:40. This will be another very long day. It is already quite warm as we leave about 7:20 a.m. for Padgaon, south of Poona. (I am told that this is about the earliest that any Indian agriculturist ever started on a field trip.)

I discover that we are to get train tickets to go to Sholapur tonight rather than driving through by car as planned. This is said to be necessary because of the bad roads, which I doubt. I believe rather that Dr. Basu wants to show me some plots that he started and also that they don't have automobiles. For the trip yesterday and the one today the Director of Agriculture furnished us with a taxi.

At the edge of the city we pass over the thin "medium black" soil which is not a Tropical Black Clay. I notice some fairly good areas that are not used, apparently for institutional reasons.

As we drive on I note that near the water courses there has been quite a lot of erosion. I see some old stone bunds or walls, not on the contour, especially across gullies. These do not seem to have been effective.

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About 11 miles south of Poona we climb into a high range of hills, or rather up an escarpment to a higher plateau. These hills are nearly barren Lithosols with little vegetation, mainly because of overgrazing. Here too, it is obvious that this trap rock is quite variable. With fencing, quite a bit of grass would grow here and perhaps even trees in the favored places. I note some red layers within the rock, which suggest that an old soil had been buried by hot lava. This red material is brittle and usually crumbles to small sharp fragments. Up on the higher level there is first a strong mezzo-relief with considerable past erosion. Some rather poor earth and stone bunds have been relatively ineffective. Most of the crops consist of rather poor sorghum.

As we go on I see a little irrigation from wells. The relief is smoother and the soils are very dark reddish brown to nearly black in the lower places. Besides sorghum I see wheat and peas. Many of the fields are freshly plowed. With controlled grazing I think trees could be had. In fact, I see old kilns which I suspect were used for charcoal at one time. Along the road here too there are some struggling banyan trees. Most of the lower branches have been cut to feed goats and cattle.

As we go on the crops are somewhat better. We meet a large caravan of large bullock carts piled high with brownish grass cuttings - poor fodder going to the city. We pass sugarcane. I don't believe the variety is quite right since most of the plants send up sterile seed stalks.

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Our road is hard and dry but very chattery.

We pass Saswad. To the west is a small green valley with good soil and irrigated sugarcane, mangoes, chick peas, etc. Then we pass more of this thin "medium black" undulating soil used for sorghum. The cultivators have some old strip bunds and a little irrigation from wells. The crop continues to be mostly sorghum with chick peas and wheat in the favored places along with some patches of irrigated sugarcane and mangoes. I see a few patches of other fruits, including a little citrus. Except where irrigated the soils are now very dry. Freshly plowed fields are dark reddish brown to reddish black.

This area could be greatly improved by bunding, mostly on the contours. Generally the gullies stabilize themselves at rather shallow depths. When the soil is 2 feet or more deep the surface is very dark reddish brown and the soil cracks into large irregular prisms. These break into irregular clods that are reasonably friable. When moistened this soil is reddish black in color.

Beneath the surface layer is a brownish weathered rock, mottled with white from lime - a mixed D, C, and C_{ca}. Unhappily, this layer is locally called "murrum" here, which is entirely unlike material called murrum in the other parts of India and in Africa.

Mr. Zene, soil physicist; Mr. Mirlikar, agronomist; and (later) Mr. G. T. Babriwala, director. There is some mixup over our appointment here because the men had expected us yesterday or later in the day. We go along the "Right bank"

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I see an area of moderate size irrigated by pumping through pipe from a well near a deep stream. The road here is very dusty. We pass a high hill with another old temple, which was said to have been constructed in the 16th century.

Dr. Basu says that analyses of the old tax maps show that these soils have lost an average of 7 inches of soil in the last 27 years. This can be only a very rough estimate since erosion activity varies widely in different places and even from one yard to the next in the same field.

We pass Walha, a good-sized village where some irrigated valley lands have citrus and other fruits, wheat, sorghum, and the other usual food crops.

As we approach our destination banyan trees drop out and in their places sisal (Agave) is planted. Then we go over a large gently undulating area of thin stony eroded soil with only patches now capable of producing even a poor crop. We cross the "Left bank" canal built in 1885. Here I see many fields of good sorghum being cut.

We pass Nira and cross the Nira River. There is severe gullying in places on either side of this river.

We come to the headquarters of this Padgaon station near Nira. We are met by the following: Mr. K. W. Joshi, soil survey officer; Mr. Zene, soil physicist; Mr. Mirikar, agronomist; and (later) Mr. G. T. Babriwala, director. There is some mixup over our appointment here because the men had expected us yesterday or later in the day. We go along the "Right bank"

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canal built in 1928 to the farm. Where we drive now the soil is just a bit sandy and looks like Reddish Chestnut.

They first take me to a museum and explain that they have detailed surveys with factorial maps (a partially coded legend of selected soil features) and a soil type map for about 67,000 acres. The types B and G of Dr. Basu's classification are most common. They usually take samples to 5 feet at intervals of 1,320 feet; but on some of the detailed soil surveys they make their profiles at 800-foot intervals. They say that boundaries are drawn where the soil slope changes. To guide the cultivators they use the 8-inch equals 1 mile village plats.

The so-called A type described by Basu and exhibited in the museum looks like a Tropical Black Clay. I suspect that the others are some kind of intergrades away from the Tropical Black Clay to Reddish Brown, Reddish Chestnut, or Non-Calcic Brown. The Tropical Black Clay seems to be the end member but a small component, areally, of a catena-like association from the trap rock.

It is said that they have given cultivators maps and explanations about fertilizers and other practices for the soils where sugarcane is being grown. I am told that they must add organic matter as manure, compost, and peanut cake to maintain soil structure and yields of sugarcane - that chemical fertilizers alone are not sufficient. Generally, they say that compost is absolutely essential.

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*Reprinted from the Bulletin of the National Institute of Sciences of India,
No. 3, 1954.*

SOILS OF THE DECCAN CANALS, THEIR CLASSIFICATION,
NOMENCLATURE AND GENESIS

By
J. K. BASU AND S. S. SIRUR

SECTION III

INDIAN SOILS, THEIR CLASSIFICATION, NOMENCLATURE AND GENESIS

SOILS OF THE DECCAN CANALS, THEIR CLASSIFICATION, NOMENCLATURE AND GENESIS

by J. K. BASU, *F.N.I., Soil Physicist to Government, Bombay State, Poona 5*, and
S. S. SIRUR, *Soil Chemist, Soil Physicist's Section, Sholapur*.

In connection with problems of sugarcane agriculture in the canal-irrigation zone of the Bombay Deccan, the soils in this area were surveyed and classified by Basu and co-workers between the year 1932 to 1944.

The Region.—The Deccan canal region is situated between the parallels of latitude 16° and 21° N.L. in the northern part of the Central zone among the long parallel strips into which the Peninsula can be divided according to the prevailing rainfall and climate. This region has a low and precarious rainfall of less than 20" per annum and on account of frequent scarcity conditions has been provided with big irrigation canals fed from great reservoirs built in the high rainfall areas in the West.

Climate, geology and soils.—The climate as described above, is continental and semi-arid in character with well-marked wet and dry seasons and is practically uniform in the whole region. Mean annual temperature 76.63° and mean annual humidity 54.56% was observed from past data. The soils which belong to the broad group of black soils are derived from the extensive basaltic rock-formation called the Deccan trap, which is petrographically very uniform in composition throughout (Wadia, 1926). The soils are mainly residual, with varying extents of local transportation and accumulation in the past, due to the undulating topography which have, however, attained comparative equilibrium at present.

Thus, as the parent rock is uniform, as well as the climate soil variation could be attributed to local differences in the chemical composition of the rock. Actually, however, soil variation both in respect of the total depth and cropping suitabilities are found to occur according to the topographical positions of the soils and also intermittent patches of alkali soil, locally known as 'chopan'. It seemed, therefore, that the undulating topography of the region is the most important single causal fact or in inducing soil variation by profoundly modifying the conditions of drainage and 'soil-climate.' Although the soil-building forces are still at work, due to the dynamic nature of the relief, yet these soils must have reached a state of equilibrium with climate, vegetation and long-standing agricultural practices.

* Soil Physicist to Government, Bombay State, Poona 5.

† Soil Chemist, Soil Physicist's Section, Sholapur.

Reconnaissance Soil survey.—A reconnaissance survey of the soils of the tract in the areas of the major canal systems was conducted, during which the morphological and chemical examination of a large number of soil profiles was carried out. According to recognised principle of grouping soils according to their distinct profile characteristics, and designating each such entity as a different type, twelve soil types were distinguished. For convenience, and pending the assignment of a suitable agreed nomenclature the types were designated by alphabetical letters, A to L, as they were identified in chronological succession (vide App. I) (Basu and Sirur, 1938, Rege and Basu, 1944).

Genesis, a Classification and nomenclature.—By means of further detailed studies of the typical profiles of the soils and also from the study of the soils occurring along a number of separate 'catenas', the mode of formation of the soils and their relative positions in the catena were ascertained. The gradual changes in the soil properties occurring along the catenas are discussed by Basu and Sirur (1942).

In figure 1, the relative positions of the soil types along the catena, the conditions of their formation and development and their physico-chemical properties, in brief are given.

The soils on the highest position of the catena are characterised by a shallow depth up to a maximum of about 2 ft., have brown and reddish hues; in their colour, possess single-grained structure, and there is no accumulation-zone of soluble salts which indicate conditions of free drainage and complete leaching. They are also comparatively coarse in texture particularly in the skeletal or immature stage, though the most mature among them show fairly high clay content. But, on the whole, they are less colloidal with lower pH and exchangeable bases.

The second group of soils are all on the intermediate position of the catena and are characterised by darker colour being dark grey to greyish black, with soil-depth over the *murram* ranging from 2 to 4 ft. They show a granular to crumb and in some cases even a slightly cloudy structure, and though there is actually no accumulation-zone of soluble salts, they show higher values at the surface than in the first group of soils, and slightly increase down the depth. The texture is also generally heavier and the soils are more colloidal than in group I, the total exchangeable bases being higher. The free lime contents are likewise higher than in group I and in most cases there are accumulation-zones below the solum.

The third group of soil as shown in the chart are situated in the lower-most position of the catena. They are usually deep having depth of over 10-12 ft. and in many cases the *murram* substratum is absent. The soils have black colour modified by grey or brown tints, and tend to have a cloddy-structure particularly if not timely tilled. The most important feature of these soils is that there is invariably an appreciably higher content of soluble salts, of which there is either a definite accumulation-zone in the lower horizons or a sharp increase with depth. The soils are highly colloidal, with high predominance of Mg and Na bases, high contents of free lime with accumulation-zones within the solum. Varying extents of these soils are found to be fairly highly sodium saturated at the surface due to the above conditions and thus attain the nature of alkali soils (Basu and Tagare, 1943).

Basu and Sirur (1938) have proposed that, in consideration of the general dark colour, crumb-structure and high base saturation these soils be

assigned to the world group of chernozems with the qualification of their being tropical and immature. With regard to their classification among the lower categories, it may be observed that the first group of high level soils may be termed oromorphie the middle group is phytomorphie and the last group is hydromorphie. It is the halomorphie group where the saline phase is predominant. The soils form an association or family, the series and types being practically coincident due to the very restricted textural variations of the surface within each soil type. This is according to expectation as the parent material is homogeneous and shows vertical uniformity (Reicken and Smith, Soil Sci. 1949). Phase differences are usually attributable to differences in depth and the degree of development or maturity which is reflected in the first and second groups by the colloidal contents, of which the exchangeable calcium was found to be a significant index. In the third group phase differences are due to salinity indicated by free salts and the exchangeable sodium contents. The units of classification can thus be represented by the following table:—

CATEGORIES

Great soil Group	Family Associates	Series and Types	Phase
Immature Tropical Chernozems	(1) Oromorphic	High level shallow soil (G, H and F)	Mature and Immature (or eroded)
	(2) Phytomorphic	Low level shallow soils (E, A, D, K and L)	
	(3) Hydromorphic	Deep soils—low lying	Normal and saline
	and (4) Halomorphic	(C, I, B and J)	

APPENDIX I

DESCRIPTION OF SOIL TYPES

A type has two horizons of uniform black colour with a tinge of red, the upper 12 in. or so having a well-defined crumb structure and interspersed with roots, and the lower horizon with a faintly crystal-like structure. The depth of the soils is about 2 to 3 ft. resting on murrum of the medium hardness, impregnated with lime.

B type is characterised by three horizons; the first horizon is about 20 in. thickness, greyish black in colour with a distinct brown shade, with a more or less cloddy structure (clods breaking up easily into crumbs under pressure), the second horizon is mottled with black and brown, brown increasing with depth; thickness 20 in. to 30 in.; a pure reddish brown horizon follows which shows concretions of lime and often gypsum crystals. The soil depth is never less than 3½ ft. but may extend up to great depths.

C type is also one of the deeper types having two or three horizons which are not sharply differentiated; the greyish black surface horizon has hard and lumpy structure often coated with incrustations of salts, but gets definitely stickier and more impervious with depth; below this, there is occasionally a reddish brown material of silty consistency, or in the shallower phase (4 ft.) a

sandy material with heavy deposits of lime. Profuse black concretions of lime are present throughout the profile.

D type has a single horizon possessing a dark grey colour with brown shade, fairly loose and granular with faint structure appearing in lower depths which attains distinct lamination in the lowest layer. Intervening between the soil and murum below is a lime band of dirty white colour and of varying thickness. The depth of the soil layer varies from 2 to 4 ft.

E type has an upper loose and friable horizon of about 12" depth and of dull greyish black colour, loamy texture, followed by a markedly compact second horizon having a slightly darker colour and laminated structure, clay-loam. Depth of soil is $2\frac{1}{2}$ –5 ft. resting on murum, grey and yellow with glauconite.

F type is shallow soil—12"–15" in depth, consisting of two well-defined horizons; the upper horizon (7"–8" thick) has a light brown colour, lighter texture loose and granular structure with broken pieces of murum; the lower horizon is darker in colour and distinctly compacted. This lower horizon is of variable thickness and in very shallow phase may often be entirely absent. The murum is hard with only a faint incrustation of lime.

G type is of a uniform dark brown colour throughout but the upper horizon has a crumb structure which yields small grains under-pressure while the lower horizon shows slight lamination with white concretions of lime and particles of well weathered murum in the lowermost parts. The murum below is fairly weathered and coated with lime. The soil depth is from 1–3 ft.

H type is also a shallow type of soil of about 18 in. depth, divisible into three well-defined horizons. The first horizon has a reddish-brown colour, loamy texture and is porous and granular; does not effervesce with hydrochloric acid. The second horizon is chocolate brown in colour, same texture with faint structure; effervesces with hydrochloric acid, roots penetrate up to this horizon only. The third horizon has the same colour but is slightly compacted; lime and pieces of murum present. Murum, thoroughly desintegrated, greenish yellow with heavy incrustations of lime.

I type soil of medium depth with three characteristic horizons. The first (0–8") is of greyish-black colour with absence of brown tinge, nutty structure, interspersed with roots, clay. The second horizon is slightly deeper in colour with penetrations of roots throughout; compacted, with crystalline structure, dries up to a very hard mass on exposure, black concretions of lime present. The third horizon is of lighter colour than the above, clay breaks up into structureless fine particles. Below, greenish yellow murum.

J type deep soil, surface layer (0–10") greyish-black clod, breaking into crumbs, clay loam; black and white nodules of lime present. The second horizon very similar to first excepting that the clods are absent; crumb structure slightly laminated. Third horizon slightly darker in colour with shaly structure showing presence of white lime nodules. Below, yellowish-white material with profuse lime nodules and pebbles; hard and structureless murum at great depth.

K type soil, fairly deep on slope and low-lying situations. Consists of four horizons; the first layer (0–8") deep-black in colour shows hard irregular clods with few pieces of murum and black nodules of lime. Second horizon consists of stiff clay showing slight tendency for lamination. The third horizon is slight-

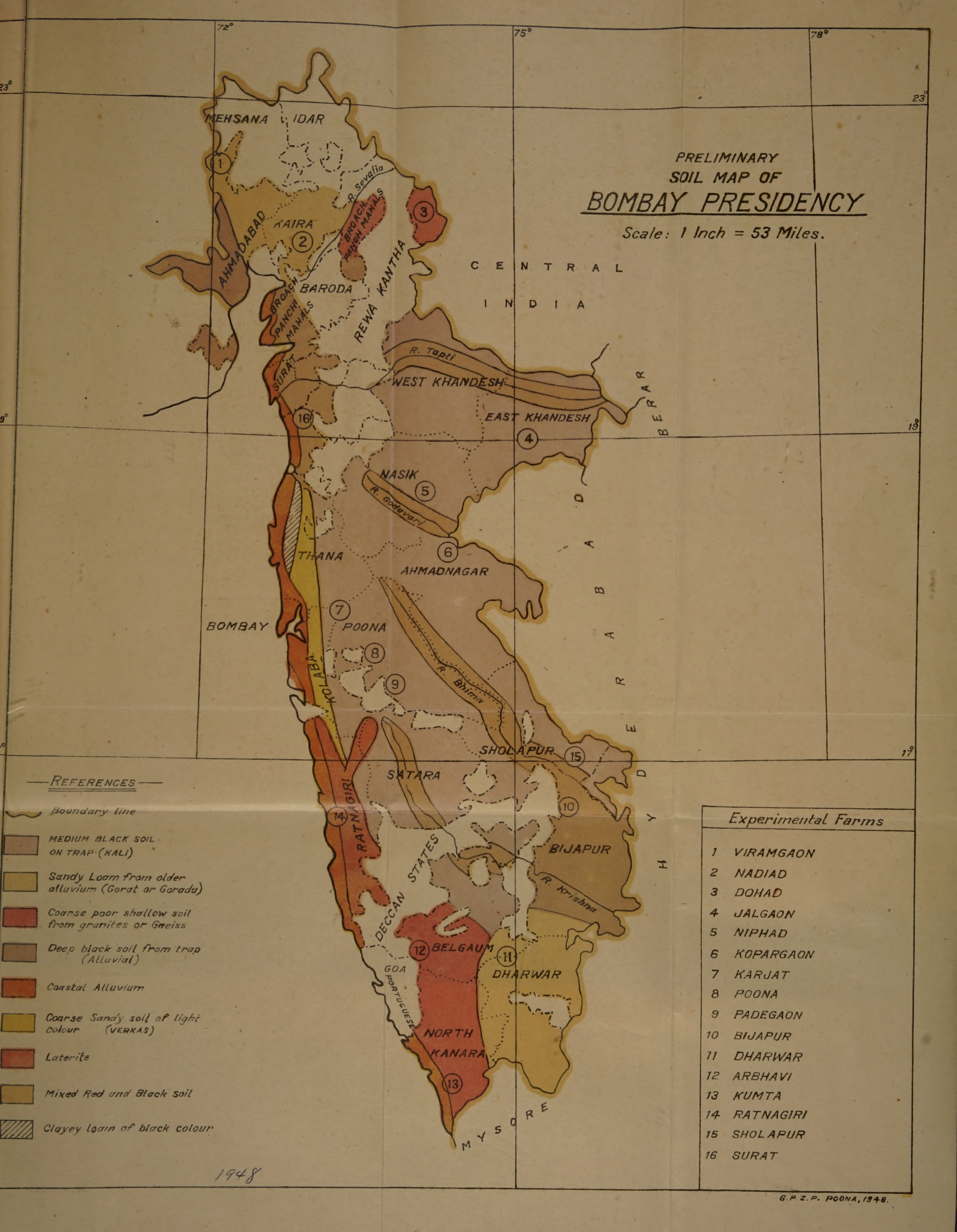
GROUP-III Deep Soils-Lowlying :- Increasing salt content or accumulation zone of salts.											
GROUP-II Low Level Shallow Soils :- Without an accumulation zone of salts but get the leachings from high level soils.											
GROUP-I High Level Shallow Soils :- Do not show a zone of accumulation of soluble salts.											
Flat.	Gently sloping.	Sharply sloping.	Sloping.	Gently sloping.	Undulating.	Sloping.	Sharply sloping.	Moderately sloping.	Gently sloping to flat.	Gently sloping to flat.	Gently sloping to flat.
Fair.	Very good.	Fair.	Inferior.	Good.	Good.	Fair.	Inferior.	Good.	Good.	Good.	Good.
Deep.	Deep.	Deep.	Deep.	Fairly near.	Fairly near.	Deep.	Near.	Fairly near.	Near.	Near.	Near.
Dark brown.	Reddish brown.	Light brown.	Greyish black.	Black with reddish tinge.	Dark brownish grey.	Deep black.	Deep greyish black.	Greyish black.	Brownish black.	Greyish black.	Greyish black.
Granular to small crumb.	Granular.	Granular.	Crumb.	Crumb.	Crumb.	Cloddy.	Hard cloddy.	Hard lumpy.	Medium clods.	Medium clods.	Medium clods.
52.0	47.0	46.0	60.0	49.0	55.0	44.0	55.0	50.0	56.0	50.0	50.0
4.0	0.6	1.0	7.0	8.3	9.4	7.0	10.0	4.0	9.0	8.0	8.0
8.3	8.3	8.1	8.6	8.5	8.8	8.5	8.4	8.5	8.8	8.6	8.6
55.0	54.0	57.0	69.0	69.0	53.0	39.0	45.0	46.0	26.0	35.0	35.0
<10	>10	>10	<10	>10	<3	...	...	<3	<3	...	...
Topography.	Drainage of substratum.	Sub-soil water table.	Colour.	Structure.	Clay%.	CaCO ₃ %.	pH value.	Ex. Calcium.	Ex. Ca/Mg.		

ly coarser and whitish in colour due to presence of lime; structure indefinite. Below, whitish soil containing about 50 per cent of white limy material, structureless and continues to a great depth.

L type soil of medium depth, surface layer (0-16"), dark greyish black colour, hard clods breaking into chunks, black nodules present; clay loam. Second horizon with same colour as above but crumb structure, very soft and porous at first but slightly compacted showing tendency of lamination in lower layers. The third layer is stiff, colour being the same as the second layer; structureless. Concretions of lime present; mixed with murum with heavy deposits of lime in lower layers where rounded pebbles are noticed. Below, hard cement-like structure made up of rounded pebbles and lime nodules.

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PRELIMINARY
SOIL MAP OF
BOMBAY PRESIDENCY

Scale: 1 Inch = 53 Miles.

C E N T R A L
I N D I A

WEST KHANDESH

EAST KHANDESH

NASIK

AHMADNAGAR

THANA

POONA

SHOLAPUR

SATARA

BIJAPUR

DHARWAR

BELGAUM

NORTH
KANARA

M Y S O R E

— REFERENCES —

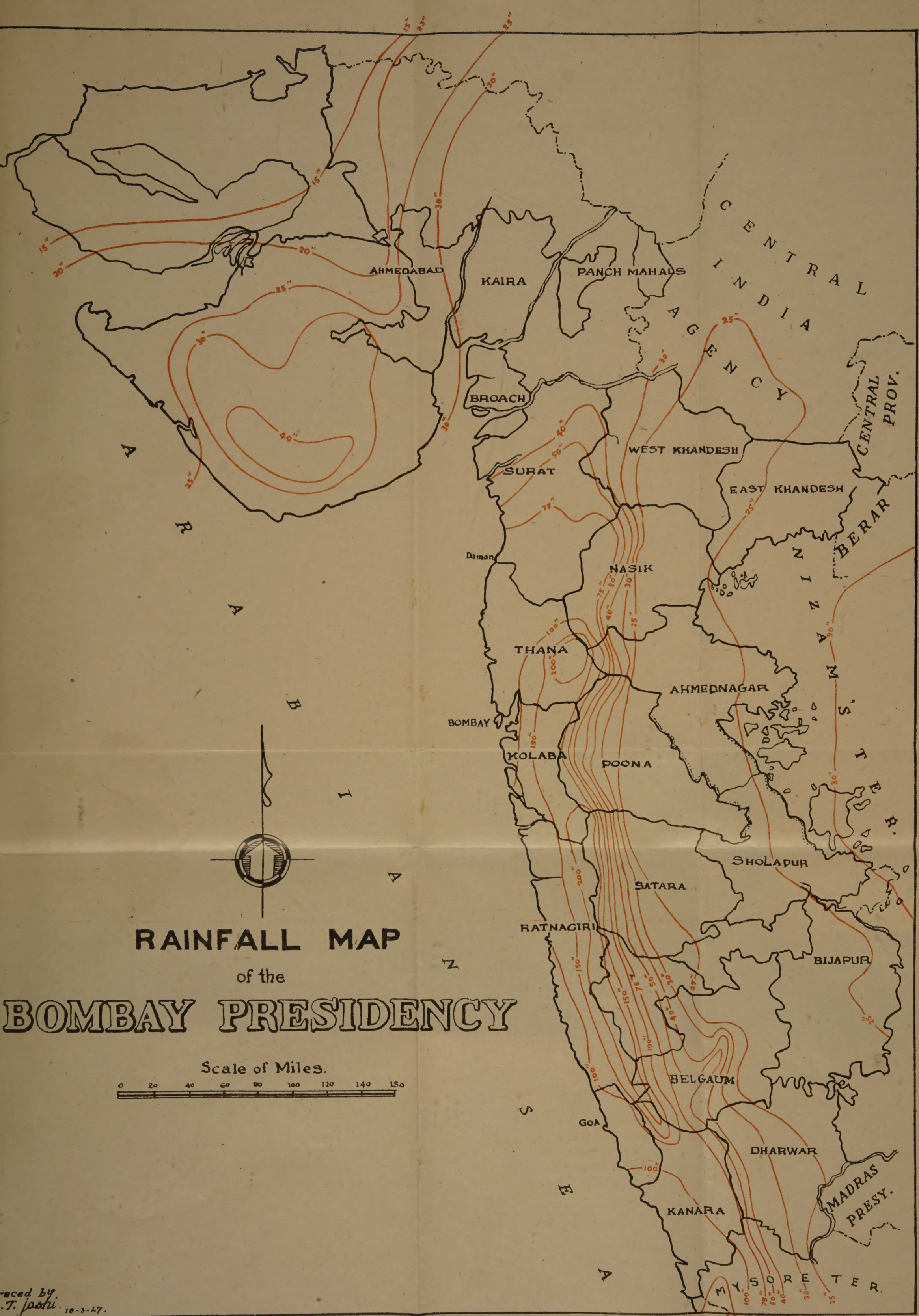
- Boundary line
- MEDIUM BLACK SOIL
ON TRAP (KALI)
- Sandy Loam from older
alluvium (Gorat or Goradu)
- Coarse poor shallow soil
from granites or Gneiss
- Deep black soil from trap
(Alluvial)
- Coastal Alluvium
- Coarse Sandy soil of light
colour (VERKAS)
- Laterite
- Mixed Red and Black soil
- Clayey loam of black colour

Experimental Farms

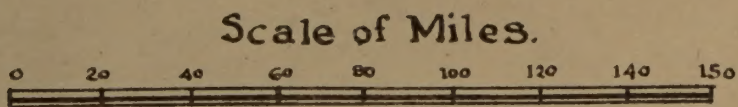
- 1 VIRAMGAON
- 2 NADIAD
- 3 DOHAD
- 4 JALGAON
- 5 NIPHAD
- 6 KOPARGAON
- 7 KARJAT
- 8 POONA
- 9 PADEGAON
- 10 BIJAPUR
- 11 DHARWAR
- 12 ARBHAVI
- 13 KUMTA
- 14 RATNAGIRI
- 15 SHOLAPUR
- 16 SURAT

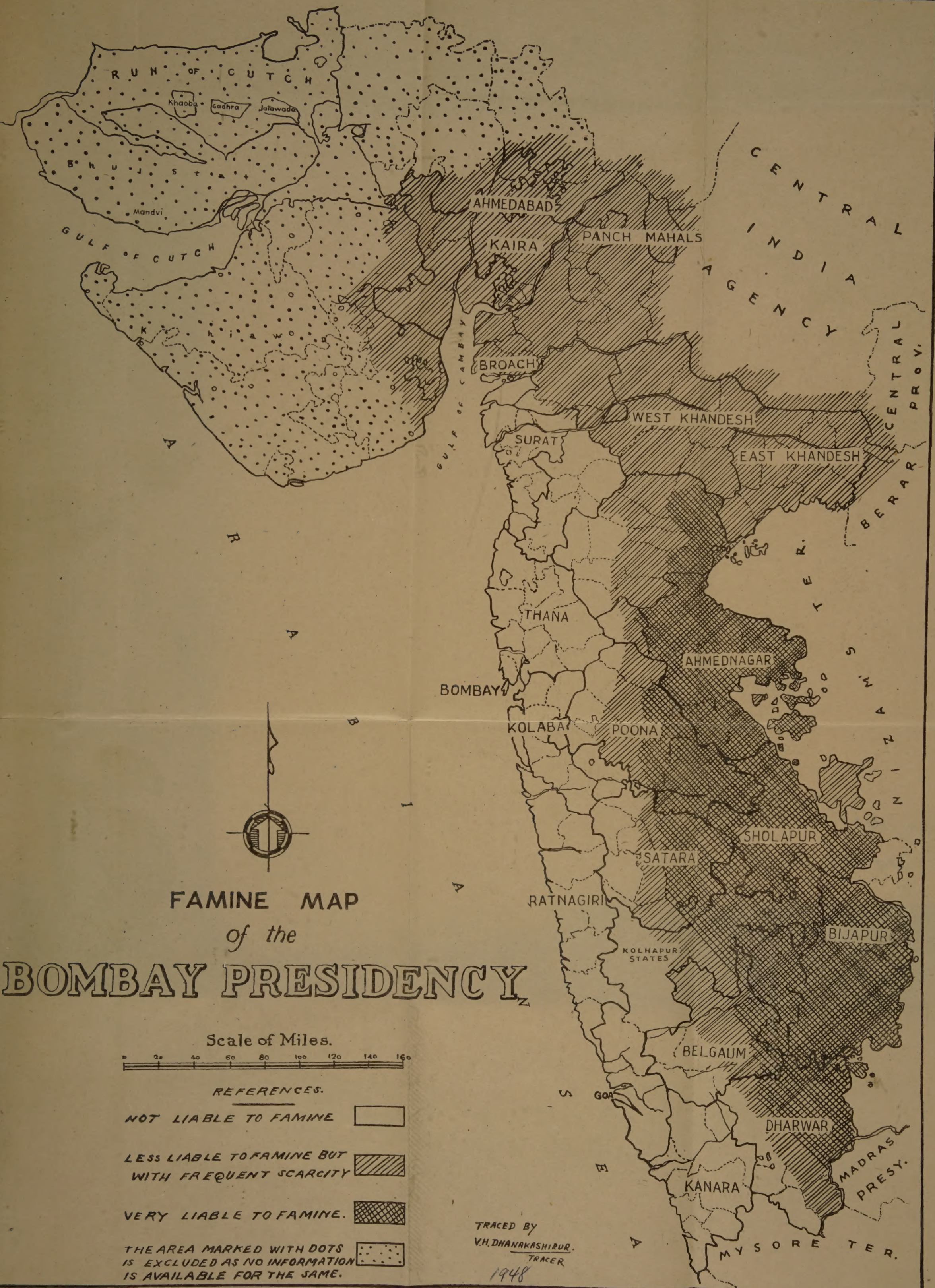
1948





RAINFALL MAP
of the
BOMBAY PRESIDENCY





Soils of Bombay State

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S OILS as the natural media for the growth of plants are the products of the combined action of climate and vegetation, including the living organisms upon the parent material over a period of time. The effects of climate and vegetation may be modified by local variations in relief or topographical situations, so as to give different kinds of soils from the same parent material under similar conditions of climate and vegetation. Depending upon the exact combination of the five independent soil-forming factors, different kinds of soils are formed and the number of such soils is bound to be very large. While it is difficult quantitatively to evaluate the effects of each of these five factors, it is possible broadly to group soils showing similar characteristics and occurring under a particular combination of the five independent variables. In order rightly to understand the nature of the soils of a particular region, one has, therefore, to see how each of the above factors has contributed to their formation. Leaving aside the effects of time which it is difficult to evaluate and also soil difference brought about by local variations in topography, it is possible to establish

a relationship between the different kinds of soils of Bombay State, on the one hand, and the effects of the other three factors of soil formation, namely, parent material, climate and vegetation, on the other.

The four important geological formations in Bombay State are the Indo-Gangetic alluvium in the north, the Deccan trap in the Central and Eastern parts of this State, a small portion of laterites in the hilly tracts in the Western Ghats and partly in the South, and the mixed formations of granites, gneisses, schists, shales, limestones, sandstones, etc., in the south. A small area of granitic rocks occurs also in parts of Banaskantha, Mehsana and Panchmahals in North Gujarat. These differences in the parent material have in certain cases contributed to the development of different zones of soils. For example, the soils derived from the sandstones of Badami in the Bijapur district are distinctly different from those derived from the basalt in the same district under similar conditions of climate and vegetation. The effects of parent material have in many cases been masked by those of the more potent factor, namely, climate. Thus,

whereas the Deccan trap has given rise to the calcareous type of soil in eastern parts like the Deccan on account of the aridity of this tract, it has given rise to lateritic soils in the southern parts of Ratnagiri and Kanara districts on account of the forest vegetation and humid climate of those districts.

Climatologically, Bombay State can be divided into three distinct zones :—

1. The arid and semi-arid zones of North Gujarat, Central Gujarat and the eastern districts of the Deccan which receive on an average 20" to 25" of rainfall annually.
2. The semi-humid zone, popularly known as transition tract, covering the western parts of the districts of Dharwar, Belgaum, Kolhapur, South and North Satara, Poona and Nasik and the southern part of the Surat district which receive 25" to 60" of rain per year.
3. The high rainfall zone of humid climate extending from the districts of Thana and Kolaba in the north through Ratnagiri on to the Kanara district in the south. The rainfall in this zone varies from 60" to 65" per year.

The climatic differences detailed above have as in other parts of the world, played a dominant role in the development of the soils of Bombay State.

While the variations in the parent material and the climate have contributed to the formation of well-defined

types of soils showing different properties of their own, local differences in topographical features have brought about considerable variations within each of these groups as a result of variation in the soil climate. Thus, in the Deccan tract which is characterised by its undulating topography, one comes across soils which are shallow and light in colour on the ridges to deep black soils in the valleys along a cross-section, each characterised by its own properties and field behaviour.

THREE TYPES OF VEGETATION

The natural vegetation of Bombay State can be broadly grouped into three categories, viz., forest vegetation, the tall and short grass type and halophytic type. There appears to be a very close relationship between these three distinct groups of vegetation and the climatic conditions under which they occur. The forest type of vegetation occurs in the regions of high rainfall and to a certain extent in sub-humid regions. The forest slowly merges into the tall grass type and then into the short grass type with an increase in the aridity of climate. The grass vegetation has given rise to highly base-saturated soils. Finally, the halophytic types represent special conditions in that they are found to grow on saline and alkaline soils only.

With the above background of the nature of soil-forming processes which have been in operation for an infinitely long time, it will now be easy to study the main kinds of soils occurring in Bombay State. Instead of discussing the different kinds of soils, the main features characterising these soils are presented in the table below :—

TABLE

Characteristics of the soils of Bombay State

Popular Names.	Medium Black Soil.	Deep Black Soil.	Goradu Soil.	Laterite Soil.	Red Soil.	Coastal Alluvial Soil.	Limy Soil.	Sandy Soil.	Saline Soil.	Alkaline Soil.
Tracts and Districts.	Part of Gujarat, East Deccan and Parts of Karnataka (Part of Panchmahals, West & East Khandesh, Nasik, Ahmednagar, Sholapur, Poona, Satara, Kolhapur, Bijapur and Belgaum).	A large part of Gujarat (Ahmedabad, Baroda, Broach, Surat) and along the banks of the rivers in the Deccan.	North Gujarat (Ahmedabad, Mehsana, Kantha, Panchmahals, Kaira, Baroda).	Southern Konkan (Southern Ratnagiri and Kanara).	Karnatak (Dharwar).	Along the coast (Broach, Surat, Thana, Kolaba, Ratnagiri, Kanara).	Parts of Karnataka and Deccan.	Part of Karnatak (Bijapur).	Along the sea coast and creeks.	All over the State.
Parent Material...	Trap (Basalt).	Trap (Basalt).	Indo-Gange- tic alluvium.	Laterite or trap.	Mixed origin, granite, schist, shales, etc.	Alluvium from trap.	Trap (Basalt).	Sand Stones.	Alluvium from trap.	Trap (Basalt).
Climate	... Arid	... Arid	... Arid	... Humid	... Sub-humid	Humid	... Arid	... Arid	Humid and sub-arid.	Arid.
Rainfall (inches)	20-25	... 20-25	... 20-25	... 60-150	... 25-60	... 60-150	... 20-25	... 20-25	... 25-150	... 20-25.
Vegetation	... Grass	... Grass	... Grass	... Forest	... Forest	... Grass	... Grass	... Grass	... Bushes	... Babul, Tarwad and alkali resistant plants.
Topography	... Undulating	... Low-lying or flat.	Flat	... Variable	... Variable	... Flat	... Variable	... Undulating.	Flat	... Flat to slightly slopy.

Characteristics of the soils of Bombay State—contd.

Popular Names.	Medium Black Soil.	Deep Black Soil.	Goradu Soil.	Laterite Soil.	Red Soil.	Coastal Alluvial Soil.	Limy Soil.	Sandy Soil.	Saline Soil.	Alkaline Soil.
Depth (feet)	... 3-5	... Over 5	... Over 5	... 3-5	... Under 3	... Over 5	... Under 3	... Under 3	... Over 5	... Over 5.
Texture	... Clay loam	... Clayey	... Sandy loam.	Clay loam	Sandy loam	Clay loam to loam.	Sandy	... Sandy	... Loam to clay loam.	Clay loam to clay.
Colour	... Brownish or Black greyish black.	... Black	... Grey to ash grey.	Red to brownish red.	Reddish brown.	Reddish grey to grey.	Freyish black.	Yellowish red.	Yellowish brown to ash grey.	Ash grey to black.
<i>Per Cent on Dry Vine Matter.</i>										
Nitrogen mgm. ...	40-80	... 50-90	... 30-70	... 150-200	... 20-50	... 60-90	... 30-40	... 20-40	... 50-70	... 50-30
C/N ratio	... 12-15	... 15-26	... 6-13	... 10-15	... 10-15	... 11-16	... 12-15	... 8-10	... 10-15	... 15-20
HCL extractable P ₂₀₅ mgm.	50-100	... 80-120	... 100-230	... 50-80	... 60-80	... 70-120	... 30-100	... 40-80	... 50-80	... 80-100
Available P ₂₀₅ 10-20 mgm.	... 15-25	... 15-25	... 15-40	... Traces to 5	4-5	... 10-15	... 3-6	... 5-10	... 10-15	... 15-20
HCL extract K ₂₀ 110-590 mgm.	... 50-200	... 50-200	... 200-400	... 80-150	... 100-150	... 100-140	... 200-300	... 100-200	... 150-200	... 200-250
Available K ₂₀ 15-20 mgm.	... 20-25	... 20-25	... 20-25	... Traces to 10	6-8	... 2-5	... 15-20	... 10-15	... 15-20	... 15-20
Lime reserve 1-5 CaCO ₃ .	... 0.5-2.5	... 0.5-2.5	... 1-5	... Traces	... Traces	... Traces	... 15-20	... < 0.5	... 0.05-2.0	... 0.5-5.0
Total, Soluble salts < 0.05	... 0.05-0.1	... < 0.10	... Traces	... < 0.1	... < 0.1	... 0.08-0.10	... < 0.1	... < 0.05	... 1-3	... 0.1-1.0
Base Exchange capacity 25-60 mgm.	... 50-70	... 25-30	... 25-30	... 15-20	... 25-30	... 25-30	... 45-55	... 5-10	... 30-40	... 50-70
Base saturation... 100	... 100	... 100	... 100	... 70-80	... 100	... 100	... 100	... 100	... 100	... 100
Sodium saturation < 15	... < 15	... < 15	... < 15	... < 5	... < 10	... < 10	... 10-15	... 5-10	... < 15	... < 15
PH	... 7.5-8.5	... 8.0-8.5	... 7.0-8.0	... 5.0-6.0	... 7.0-7.5	... 6.8-7.2	... 8.0-8.5	... 7.0-7.5	... 7.5-8.0	... 8.5-9.5

INFLUENCING FACTORS

Among the various factors which influence crop yields, the supply of nutrients, good physical condition of soil, and absence of saline and alkaline conditions may be considered to be necessary, the most important ones in which the majority of soils are found to be deficient are N, P, K or the so-called "big three". In order to understand the fertility status of any soil, therefore, it is necessary to know not only the contents of these elements in the soil but also the other factors such as salinity, alkalinity, texture, physical conditions, etc. Coming to nitrogen, it will be observed that with the exception of the lateritic soils of the Ratnagiri, Kolaba and Kanara districts, all the soils of Bombay State are poor in their nitrogen content. They are, therefore, found to respond to manuring with nitrogenous fertilizers. All the soils are low in the content of organic matter and hence periodical application of organic matter like compost, farmyard manure, etc. is found to be necessary to maintain these soils in a good physical condition. It has further been observed that all the soils of Bombay State show better response to fertilisers in the presence of adequate supplies of organic matter than in its absence.

As a rule, phosphorus is present in soil in an inert form which in the course of time becomes available to the plant through various biochemical transformations. Therefore, at any one time, only 10 per cent. to 20 per cent. of this potential source is in an available condition. Judged by the conventionally accepted standards for the soils

of the western countries, the majority of Bombay soils may be considered low in the contents of hydrochloric acid-soluble phosphorus and more so the soils of the lateritic nature. The *goradu* soils of alluvial origin are, however, an exception and they are fair in the contents of the HCl soluble phosphorus. The available phosphorus follows more or less the same trend. Thus, while the medium black, the deep black and the coastal alluvial soils are fair in the supply of available P, the red soils of a mixed origin, the limy soils of Karnatak and the soils of the lateritic type are very low in available P. In fact, the lateritic soils are the poorest in this respect. They are, therefore, expected to respond to the application of phosphate and this is supported by the results of experiments in which more or less a linear response to phosphatic fertilisers has been observed in these soils.

POTASH STATUS

As regards the potash status, it may be noted that with the exception of the lateritic soils, the red soils, the sandy soils and the coastal alluvium, the majority of the soils of Bombay State are fair in the content of HCl soluble potash. The available potash, which constitutes in general 10 to 20 per cent. of the HCl soluble fraction, follows more or less the same trend. The deficient soils are likely to respond to potassic manuring and this has to be confirmed by field experiments.

In general, the lime reserve of the majority of soils in Bombay State is fairly high and this has contributed to the saturation of the clay complex with Cations. Only the lateritic soils are found to be poor in CaCO_3 and hence

they have shown considerable response to liming in the form of dolomitic limestone.

With the exception of the lateritic types, the majority of the soils are on the alkaline side of neutrality. The alkalinity becomes a major problem particularly when one has to deal with irrigated crops such as those in the canal zones, where it has been found to be necessary to resort to the use of soil amendments like gypsum, sulphur, molasses, etc.

SPECIAL SOIL TYPES

In addition to the different kinds of soils discussed so far, there are two special types which are found to occur extensively in Bombay State. They are the saline and alkaline soils. The salinity may be due to the inundation of the soils with sea-water, as in areas along the West Coast, where these soils are locally known as Khajan or Khar lands, or it may be due to saline nature of the underground water, as in certain parts of North Gujarat. In either case, they become unfit for cultivation unless the soils are improved by irrigation with sweet water and ameliorative measures. The saline soils are characterised by the presence of a high quantity of salts, slightly alkaline reaction, low lime reserve and fair to poor amounts of fertility constituents like N, P and K. The saline soils of the West Coast are found

to be suitable for the salt land varieties of paddy. The alkalinity in the soils may be caused as a result of bad drainage, over-irrigation, and subsequent rise in the water table. Such soils occur very widely all over the State and particularly in areas commanded by the canals in the Deccan, Gujarat and Karnatak tracts. There are other cases where the alkalinity is caused by such conditions as salinity of irrigation water, basin shaped topography and aridity of climate. They are characterised by high sodium saturation, alkaline reaction, high lime reserve and fair amounts of fertility constituents. On reclamation, they yield excellent crops.

Mention may also be made of the occurring at the foot of the Western sandy soils derived from sand stone in parts of the Bijapur district and those Ghats. The former, in general, are poor in fertility constituents and can be described as 'hungry soils' on account of their sandy nature. The latter at the foot of the Western Ranges of hills vary considerably in their nature, depending upon the topographical situation. On the slopes, they are shallow and poor in fertility constituents, and in the low-lying areas, they are deep, fairly fertile, and well-suited for the cultivation of paddy.

[Please see the soil map of Bombay State inserted in this issue]

[Reprinted from THE FARMER for June 1956]

Here they make it mostly from straw and manure. I am told that most of it is made in a pit and is turned twice and ready for use in 6 months. I am told that the phosphorus fixation in the black soils is closely related to their lime content, the more lime the more fixation. They are able to correct it with superphosphate and organic matter.

By both manuring and irrigation they can reduce the salt in the saline soils. I am told that with this treatment they have reclaimed some soils within 4 or 5 years that originally had 15 to 25 percent exchangeable sodium.

It was found here that phosphate was best applied in furrows at 6-inch depths. They are trying to figure out ways to reduce the need for chemical nitrogen. They now use 450 pounds^{a/} per acre of nitrogen as ammonium sulphate over a 6-month period plus about 100 pounds P_2O_5 and 100 pounds of K_2O . A good 18-month crop of cane gives 62.5 tons with 11.5 percent sugar. About 55 percent of the cane in this State is the 18-month crop planted in June or July.

We start for the field. Dr. Basu gives so many sharp and conflicting orders that our guides here are a bit confused.

I am told that there are 257 acres in this experimental farm of which 80 to 90 acres are used for sugarcane. But they also have sorghum, bananas, wheat, fruit, and vegetables, chick peas, tomatoes, and sweet potatoes.

^{a/}Added later: Although my notes are clear on this item, they are possibly in error.

added later: Although my notes are clear on this item, they
tomatoes, and sweet potatoes.
have sorghum, bananas, wheat, fruit, and vegetables, chick peas,
of which 80 to 90 acres are used for sugarcane. But they also
I am told that there are 350 acres in this experimental farm
conflicting orders that our guides here are a bit confused.
We start for the field. Dr. Haas gives so many sharp and
in June or July.
55 percent of the cane in this State is the 18-month crop planted
crop of cane gives 62.5 tons with 11.5 percent sugar. About
about 100 pounds P_2O_5 and 100 pounds of K_2O . A good 18-month
acre of nitrogen as ammonium sulphate over a 6-month period plus
the need for chemical nitrogen. They now use 450 pounds per
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reclaimed some soils within 4 or 5 years that originally had
the saline soils. I am told that with this treatment they have
By both manuring and irrigation they can reduce the salt in
phosphate and organic matter.
time the more fixation. They are able to correct it with super-
black soils is closely related to their lime content, the more
use in 6 months. I am told that the phosphate fixation in the
most of it is made in a pit and is turned twice and ready for
Here they make it mostly from straw and manure. I am told that

I first look at a profile of what Dr. Basu calls type A.
The soil has been much disturbed and is now irrigated.

- | | | |
|-------|---------|---|
| Ap | 0 - 8" | Dark reddish-black (about 2.5YR 2/1) clay that digs out in mixed cloddy and and poor blocky that is fairly easily friable. |
| AB(?) | 8 - 20" | The soil looks about like the horizon above except that it is slightly prismatic with some coatings along the structural breaks. Plastic when moist. The lower wavy boundary varies from 16 to 24 inches. |
| C | 20 - 25 | Mottled brown and greenish gray, rotten basaltic trap with some white specks of lime. The upper boundary is fairly sharp but wavy. I suspect that there was moderate gilgai under natural conditions. |

We are so hurried that one hardly has a chance to do anything with the great rush and all the questions.

I am shown a group of lysimeters for each of the 6 types of soil under rotation.

I am taken to another part showing the B type of Dr. Basu's classification, which I think can be fairly included with the Tropical Black Clay. Here, too, the surface soil has been disturbed and the land is irrigated.

- | | | |
|-------|---------|---|
| Ap | 0 - 5" | Reddish-black to black clay that is moderately cloddy. It is hard when dry but friable with some difficulty. |
| AB(?) | 5 - 32" | Dark reddish-brown (5YR 2/1.5) clay. Now that it is slightly dry the soil has coarse prismatic structure that falls into angular medium blocky. Some clay skins are exposed. The wavy lower boundary varies from about 26 to 38 inches. |

I first look at a profile of what Dr. Basu calls type A.

The soil has been much disturbed and is now irrigated.

Dark reddish-black (about 2.5YR 2/1) clay that digs out in mixed cloddy and and poor blocky that is fairly easily friable.

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Tropical Black Clay. Here, too, the surface soil has been dis-

turbed and the land is irrigated.

Reddish-black to black clay that is moderately cloddy. It is hard when dry but friable with some difficulty.

Dark reddish-brown (2.5YR 2/1.5) clay. Now that it is slightly dry the soil has coarse prismatic structure that falls into angular medium blocky. Some clay skins are exposed. The wavy lower boundary varies from about 26 to 38 inches.

- 169 -



K-2451. Feb. 2, 1958. Padgaon, south of Poona. A view of the first profile described at this station, under bananas.



K-2452. Feb. 2, 1958. Padgaon, south of Poona. Sugarcane on a long soil like the second profile described at this station.

Finally, we get some half-cooked chicken and cabbage. So I continue

IV

12451

K-2451. Feb. 2, 1958. Padagon, south of Poma. A view of the first profile described at this station, under bananas.

IV

12452

K-2452. Feb. 2, 1958. Padagon, south of Poma. Sugar cane on soil like the second profile described at this station.

B	32 - 35"	Transitional
C _{cs}	35 - 46"	Dark reddish-brown (about 5YR 3/2), mottled with light brown, clay. This layer contains crystals of gypsum.
C ₁	46 - 56"+	Dark reddish-brown (about 5YR 3.5/2) clay that is plastic and sticky but pervious.

The rock is said to be down about 3 or 4 feet more.

I am shown some small plots with many so-called permanent manurial treatments but having no crop. I can see no point to the experiment or any differences in the soil, but of course these can be measured in the laboratory.

We stop for a moment at the meteorological instruments. They get 120 inches of evaporation from free water and 25 inches of rain. The soil here cracks into hexagons about 6 or 8 inches across.

I am not shown any compost in pits but I do see some piled up along the irrigation canal. I take some photos of a fertilizer drill and of a machine for breaking clods.

I get the impression that a lot of good work is being done at this Padgaon station but there is a good deal of confusion over names. I should say that most of the soils are in a transitional or intergrade position between lithosolic Reddish Brown and Tropical Black Clay.

The laboratories are clean but I get the impression that they are clean in anticipation of my visit. We then go to the home of the director for lunch. Apparently he had not expected us, so we have a long wait. By repeated demands I get some tea, bread, and bananas. Finally, we get some half-cooked chicken and cabbage. So I continue

B	32 - 35"	Transitional
Ccs	35 - 45"	Dark reddish-brown (about 2YR 3.5/2), mottled with light brown, clay. This layer contains crystals of gypsum.
C1	45 - 55"+	Dark reddish-brown (about 2YR 3.5/2) clay that is plastic and sticky but pervious.
		The rock is said to be down about 3 or 4 feet more.

I am shown some small plots with many so-called permanent manurial treatments but having no crop. I can see no point to the experiment or any differences in the soil, but of course these can be measured in the laboratory.

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K-2453. Feb. 2, 1958. Padgaon, south of Poona. View of permanently manured plots.



K-2454. Feb. 2, 1958. Padgaon, south of Poona. Compost on the margin of the irrigation canal.

K-2455. Feb. 2, 1958. Padgaon, south of Poona. Machines for breaking sugar. The one at the right is called, "waine."

X

K2453

Feb. 2, 1958. Paduan, south of Poma. View of permanently manured plots.

7

K2454

Feb. 2, 1958. Paduan, south of Poma. Compost on the margin of the irrigation canal.

- 170 -

with the bread, rice, and bananas. Only by persistence do I get
the car on

We also

a few pictures

5 percent

and goats

soil is too

low yields.

water consumption

a very hard

housed in small fibrous tents. Yet despite their poverty,

people have
K-2455. Feb. 2, 1958. Padgaon, south of Poona. Fertilizer
drill.

As in the Great Plains, many little whirlwinds sweep across
the road.

In 1958

We pass

We reach

road. There

and the

I note

people sit

We reach

tonight.

field clothes. The Department of Agriculture had not put a road

at our disposal.
K-2456. Feb. 2, 1958. Padgaon, south of Poona. Machines
for breaking clods. The one at the right is called, "maine."
more tired from riding in the tiny jeep.



K-2455. Feb. 2, 1958. Padagon, south of Poonn. Fertilizer
drill.

K2455

A

K-2456. Feb. 2, 1958. Padagon, south of Poonn. Machines
for breaking clods. The one at the right is called "maise."

K2456

A

with the bread, tea, and bananas. Only by persistence do I get the car on the road at 1:10.

We drive back to Poona by way of Satara and Sirwal. I take a few pictures along the road. Much of the soil has about 1 to 5 percent slope and is very thin. South of Satara I see sheep and goats pasturing on eroded hills and gentle slopes where the soil is too thin for cultivation. This poor stony soil gives low yields. But many of the fields would be good with bunds for water conservation and a little fertilizer. The people here have a very hard life, especially the nomadic field workers who are housed in small fibrous tents. Yet despite their poverty, the people here seem much healthier than those near Calcutta.

As in the Great Plains, many little whirlwinds scamper across the road.

In favored places, soils on the old terraces are reddish black. We pass Sirwal on a large terrace some parts of which have irrigation.

We recross the Nira River and again have banyan trees along the road. There is a great contrast between the thin soils of the uplands and the deep ones on these old stream terraces.

I note here little platforms scattered along the fields where people sit to scare the birds away.

We return to Poona about 3:25 p.m. I wash and pack for the trip tonight. But I decide to go to tea and take the train trip in my field clothes. If the Department of Agriculture had not put a taxi at our disposal for these trips near Poona, I should have been even more tired from riding in the tiny jeep.

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K-2458. Feb. 2, 1958. Satara. Making cotton-picking baskets.



K-2457. Feb. 2, 1958. A bit southwest of Nira. A view of stony uplands that have probably lost more than a foot of soils to become nonarable.



82458

K-2458. Feb. 2, 1958. Salar. Making cotton-picking baskets.



K-2457. Feb. 2, 1958. A pit southwest of Wira. A view of stony uplands that have probably lost more than a foot of soils to become nonarable.



K-2460. Feb. 2, 1958. Near Satara. A charsa well. A large inclined plane near the well. Bullocks pull huge buckets of water by walking down the plane.



K-2459. Feb. 2, 1958. Near Satara. Ineffectual old stone terraces on eroded soil from the trap rock.

K-2460. Feb. 2, 1958. Near Satar. A charas well. A large inclined plane near the well. Bullocks pull huge buckets of water by walking down the plane.

K2460

K-2459. Feb. 2, 1958. Near Satar. Infertile old stone terraces on eroded soil from the trap rock.

K2459



K-2496. Near Satara, south of Poona. Sheep and goats on eroded, lithosolic dark brown soil from trap rock, used as common pasture. Old ineffective, abandoned terraces in background.

K-2502. Nov. 2, 1939. 3 miles south of Satara. Stacks of
 bundles of straw at the edge of a village. Old temple in the
 background.

K-2496. Near Satare, south of Poona. Sheep and goats on eroded, lithic soil dark brown soil from trap rock, used as common pasture. Old ineffective, abandoned terraces in background.

K-2496



K-2461. Feb. 2, 1958. 6 miles north of Satara. Rope making.



K-2562. Feb. 2, 1958. 2 miles south of Sirwal. Stacks of sorghum straw at the edge of a village. Old temple in the background.

IX

2461

K-2461. Feb. 2, 1958. 6 miles north of Gatare. Hope making.

IX

2462

K-2562. Feb. 2, 1958. 2 miles south of Siwal. Stacks of sorghum straw at the edge of a village. Old temple in the background.

- 171 -

Unhappily I discover I must visit the headquarters of the Botanical Surveys, which is situated in the law school! Here I meet briefly Mr. and Mrs. R. C. Hill, of the Kansas State team. We then all go for tea chez G. F. Puri. His home is very nice indeed.

After tea we are back to the hotel; get our bags packed

and go to

There

who announce

red-shirt

is wait.

is for some

space.

Fifty

Roy, Khalid



long ride I stretch out on my bedroll and happily fall asleep. Thus one day passes into another.

K-2463. Feb. 2, 1958. South of Poona. Typical bullock cart loaded with straw. February 2. We arrive in Sholapur at 12:10 a.m. and I am taken to the European Guest House. I have a very nice room.

I am up for breakfast at 7:30. This promises to be a hot day. The city of Sholapur has a population of about 200,000. They have many textile mills. The rainfall is around 25 inches but quite erratic. I meet Mr. Dodwell, General Manager of the textile mills. He had sent his car for me last evening and made the guest house available to us.

Unhappily I discover I must visit the headquarters of the Botanical Surveys, which is situated in the Law School! Here I meet briefly Mr. and Mrs. R. C. Hill, of the Kansas State team. We then all go for tea chez G. S. Puri. His home is very nice indeed.

After tea we are back to the hotel; put our gear in the car; and go to the railroad station.

These stations are crowded and very confusing to me. No one who amounts to anything at all can carry even a small parcel. The red-shirted boys carry the luggage on their heads. All I can do is wait. I don't know where the railway car is or where my luggage is for some time. There is an argument with the conductor over the space.

Finally to my amazement we all get into one compartment - Basu, Roy, Khullar, and I and leave for Sholapur at 7:30 p.m. During the long ride I stretch out on my bedroll and happily fall asleep. Thus one day passes into another.

February 3: We arrive in Sholapur at 12:10 a.m. and I am taken to the European Guest House. I have a very nice room.

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He had sent his car for me last evening and made the guest house avail-

able to us.

We leave at 8:15 and drive south to an experimental area, called Honnuragi, which is mainly cultivators' land. Besides Roy, Basu, and Khullar we have Dr. Donahue, Mr. M. M. Kibbe, soil scientist, Mr. V. D. Tagave, soil chemist, Mr. D. K. Dhekne, principal soil conservation officer, and Mr. L. B. Pandya, soil conservation engineer.

At the edge of the city there is undulating thin, very dark brown soil near the river. Some of it is eroded and is wasteland. The cropland is used for sorghum, wheat, and chick peas. I notice quite a few bunds here but they are a bit too far apart. We pass some nice fields that have been bunded for 15 years. As the land form gets smoother the soil becomes nearly black. In the low places it is black. These black soils are said to contain about 60 percent clay, to crack badly, and to contain lime. They are said to erode on slopes above about $1\frac{1}{2}$ percent. They are having great difficulty with the bunds on these heavy black soils. Apparently the soil cracks and the water cuts through them. The soils I see here are used mostly for sorghum. In some of the fields the stands of sorghum are poor, I suspect from poor germination. I even see one patch of poor tobacco along here.

After we cross the Sina River we are on gently to strongly undulating dark brown soil where the bunds are ineffective because they were put where the cultivators wanted them, in straight lines along field boundaries. I am told that the experiments here at

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Honmuradi were laid out fairly recently on 432 acres of cultivators' land. I look at the soil in a field of sorghum. Now that it is dry there are cracks of about 1 to 2 inches wide and 12 to 20 inches deep. The soil mulches naturally. Where the pit is made the soil has about one percent slope. The crop consists of a mixture of chick peas and safflower.

- | | | |
|--------------------|-----------|---|
| A _{p10} | 0 - 1/2" | Very dark gray to black (about 5YR 2.5/1 to 2.5YR 2/1) medium hard granular clay. |
| A _{p11} | 1/2 - 5 | Like the above in color except for some small dark gray mottles. The soil is massive with irregular breaking into fairly hard clods about 2 to 6 inches across. |
| A ₁₁ | 5 - 20 | Black (2.5YR 2/1) heavy clay. The soil has deep cracks 1/2 to 1 inch wide about 20 inches apart. It breaks into angular blocky. Many of the faces are somewhat coated with clay. The horizontal planes near the margins of the cracks are tilted about 45 degrees, suggesting upward heaving. |
| B ₂ (?) | 20 - 52 | Reddish-black clay. Some of the cracks extend down into this horizon. The soil breaks into large blocky aggregates with clay skins. Here too, the horizontal planes are tilted upward away from the cracks. (I suspect the clay content is higher than 60 percent.) |
| B ₃ | 52 - 60 + | Black clay (10YR 2.1/5). There is less cracking in this horizon and less developed angular blocky structure. I see some small spots of lime. The material is plastic and sticky when wet. |

I am told that decomposed rock lies at 10 to 15 feet and the water table during the dry season is at about the same depth. I should call this a true self-mulching Tropical Black Clay. It seems

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A₁₀ 0 - 1 1/2"

Like the above in color except for some small dark gray mottles. The soil is massive with irregular breaking into fairly hard clods about 2 to 6 inches across.

A₁₁ 1 1/2 - 2

Black (2.5YR 2/1) heavy clay. The soil has deep cracks 1/2 to 1 inch wide about 20 inches apart. It breaks into angular blocky. Many of the faces are somewhat coated with clay. The horizontal planes near the margins of the cracks are tilted about 45 degrees, suggesting upward heaving.

A₁₂ 2 - 20

Reddish-black clay. Some of the cracks extend down into this horizon. The soil breaks into large blocky aggregates with clay skins. Here too, the horizontal planes are tilted upward away from the cracks. (I suspect the clay content is higher than 60 percent.)

B₂(?) 20 - 52

Black clay (10YR 2.1/5). There is less cracking in this horizon and less developed angular blocky structure. I see some small spots of lime. The material is plastic and sticky when wet.

B₃ 52 - 60 +

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K-2464. Feb. 3, 1958. Experimental farm at Honmuragi, near Sholapur. Surface cracks in cultivated Tropical Black Clay during dry season.



K-2465. Feb. 3, 1958. Experimental farm at Honmuragi near Sholapur. View near profile of Tropical Black Clay. Dr. Basu is at my right.

XI

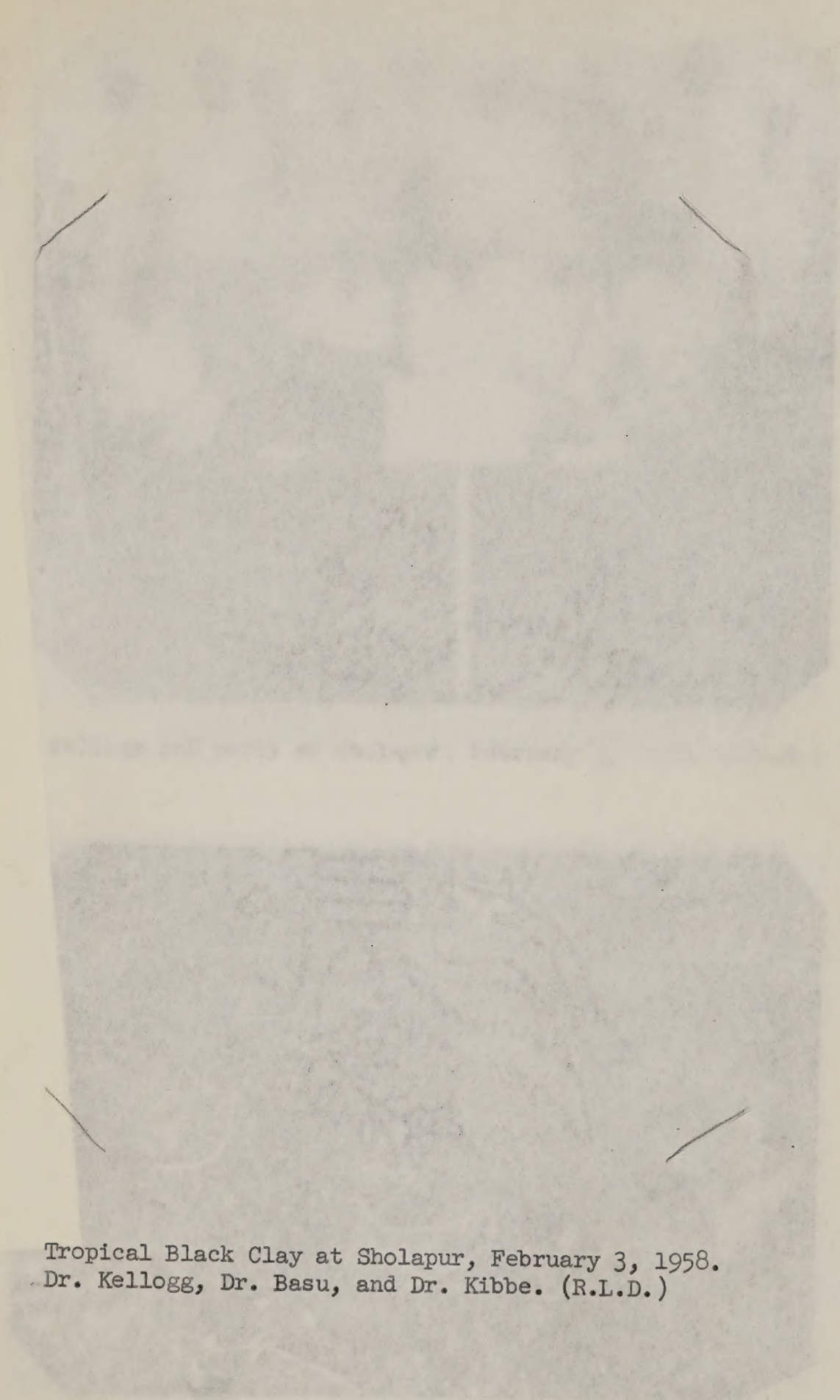
K2464

K-2464. Feb. 5, 1958. Experimental farm at Hommura, near
Sholapur. Surface cracks in cultivated Tropical Black Clay
during dry season.

XII

K2465

K-2465. Feb. 5, 1958. Experimental farm at Hommura near
Sholapur. View near profile of Tropical Black Clay. Dr. Basu
is at my right.



Tropical Black Clay at Sholapur, February 3, 1958.
Dr. Kellogg, Dr. Basu, and Dr. Kibbe. (R.L.D.)

Cracks in surface of black tropical clay. (R.L.D.)



Kellogg and party at Sholapur, February 3, 1958. (R.L.D.)



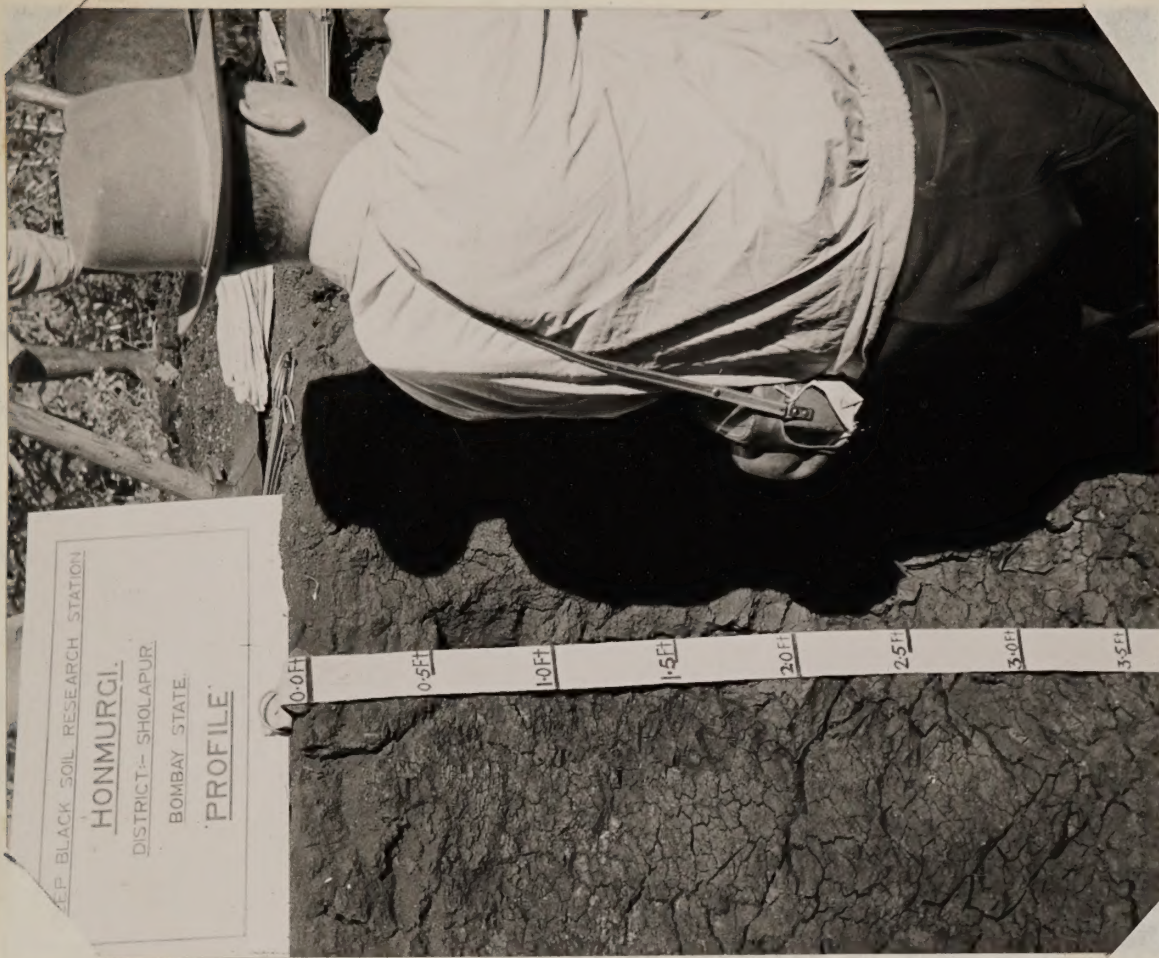
Cracks in surface of Black Tropical Clay. (R.L.D.)

13

Keller and party at Sholapur, February 3, 1958. (R.L.D.)

14

Cracks in surface of Black Tropical Clay. (R.L.D.)



Sholapur
(R. L. D.)



Kellogg at
February 3, 1958.

(M. G. D.)
Эпопея.

Всего 3, 1828.
Копия с

15

16

obvious that there has been much movement within the soil and great pressure on the blocks. No doubt this area gets additional water above the rainfall from the slight elevations around it.

This farm is divided into three blocks and each block has 12 treatments at random with bunds 16, 20, or 24 square feet in cross section and spaced at 150 feet to 300 feet. Although the slope varies, it averages about 1.2 percent. This job does not look good to me. They compromise with cultivators and put the bunds on the field lines so they are only roughly on the contour. They have no graded bunds (at an angle to the contour) nor do they have proper outlets prepared.

Yet this layout was said to be dictated by some statistician! It is very silly indeed to waste a lot of time on statistics when the universe is not uniform nor even what was intended in the plan. Such work is giving no useful information on what system is best for these soils.

They tell me that this soil can go about two years without rain and have a crop. But during prolonged drought there is no crop the third year.

We all get into cars in order to go to the research station, which is on the other side of the city. On the uplands I see them harvesting sorghum. This land gives only one crop a year. I am told that rains come in June and then there are essentially no rains in July and August. There are rains again in September and the crop is planted afterwards. Where they do have somewhat sandier soils, with careful water conservation two crops of grain may be taken.

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I notice that cultivators pile up the dry sorghum fodder and then cover it with soil to protect it from the wind.

As we drive through the margins of Sholapur, I see some very colorful local markets. In front of the simple homes many men and women are weaving beautifully colored cotton saris.

We come to the agricultural research station just east of Sholapur on what is called the Mulegaon Farm.

I am first taken to a shallow pit in the so-called "medium black soil." This has been much cultivated and I see some lime in the very surface. The slope is about one percent. The soil now has a sorghum crop.

Ap10	0 - 1"	Black clay with hard medium granular structure.
Ap11	1 - 8	Nearly black (5YR 2.5/1) clay that is cloddy, brittle, and hard when dry. When moistened the soil is essentially black.
B	8 - 13	Nearly black clay with irregular vertical cracking and coarsely blocky structure with slickensides. Here too, the horizontal faces near the cracks have regular angles suggesting old gilgai. The wavy lower boundary may be as much as 18 inches from the surface.
C	13 - 24	Mottled brown and gray, coarse, permeable rotten rock with some lime in it.

I notice a little lime scattered throughout the solum. I am told that the rock is quite hard at 30 inches but I presume it is permeable to water. Yields of sorghum are said to be around 133 pounds of grain. This yield can be increased one and one-half times or doubled with good practices. On this soil sorghum is followed by chick peas but they can get only one crop a year I am told. It is said to be only 20 feet to water now in a local well.

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Ap10	0 - 1"	Black clay with hard medium granular structure.
Ap11	1 - 8	Nearly black (2YR 2.5/1) clay that is cloddy, brittle, and hard when dry. When moistened the soil is essentially black.

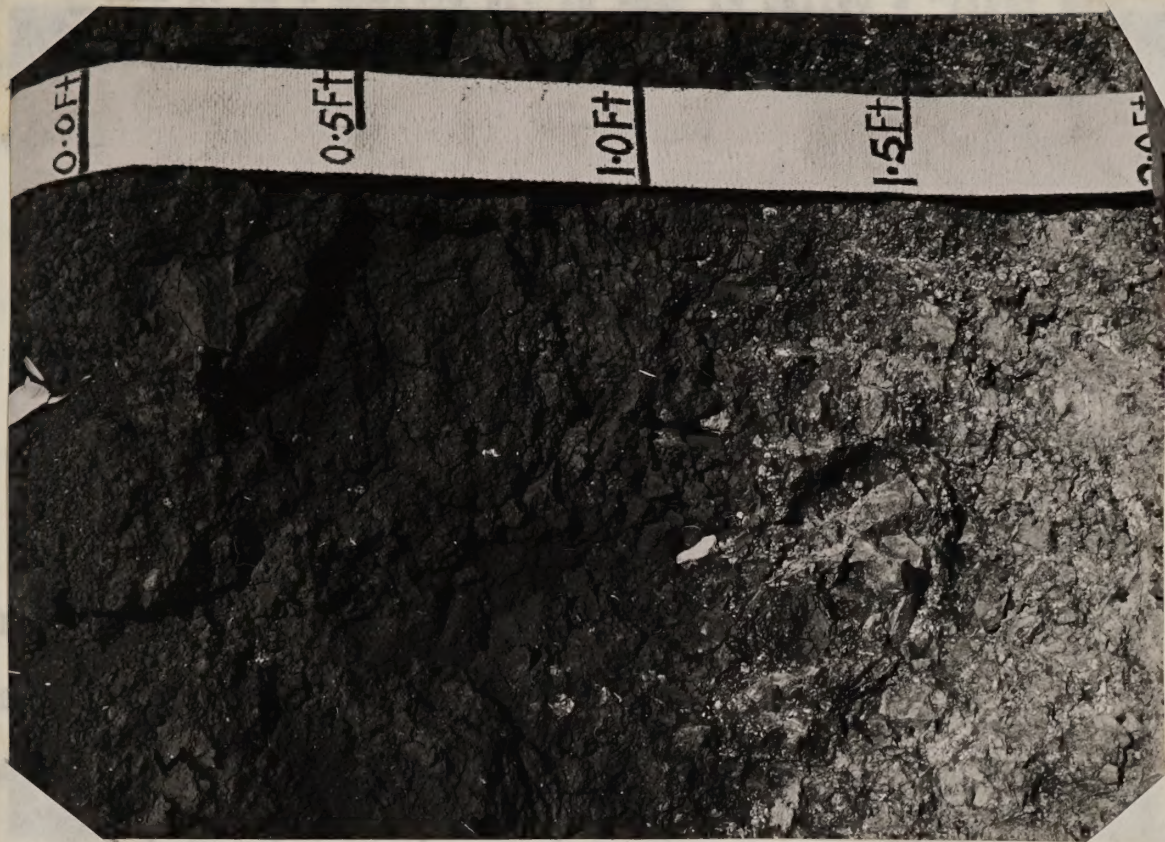
B	8 - 13	Nearly black clay with irregular vertical cracking and coarsely blocky structure with slickensides. Here too, the horizontal faces near the cracks have regular angles suggesting old gilas. The wavy lower boundary may be as much as 18 inches from the surface.
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C	13 - 24	Mottled brown and gray, coarse, permeable rotten rock with some lime in it.
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I notice a little lime scattered throughout the solum. I am told that the rock is quite hard at 30 inches but I presume it is permeable to water. Yields of sorghum are said to be around 133 pounds of grain. This yield can be increased one and one-half times or doubled with good practices. On this soil sorghum is followed by chick peas but they can get only one crop a year I am told. It is said to be only 20 feet to water now in a local well.



Kellogg looks at a "medium black" soil at Sholapur, Feb. 3, 1958 (R.L.D.)



The soil (R.L.D.)

(D.L.R.) 1000 000

"World without" & the school children
"World without" & the school children

11

11

11

11

I then go to a shallow pit in what is called a "light shallow" soil. This is on a slightly higher slope where there has been considerable erosion.

A_p 0 - 5" Dark brown gravelly clay (7.5YR 3.5/2) mottled with yellowish brown and white. This is a mixture of rotten rock and clay like that in the B of the previous profile. The structure is mixed cloddy and granular.

C₁ 5 - 12 Rotten rock with some staining, which merges into hard trap rock beneath.

On soils of such low water-holding capacity they grow a legume called "tur," one of the pigeon peas, mixed with bajari, a millet. This is sown in June or July; the millet is harvested in September; and the pigeon peas in December or January.

Then I am taken to the usual erosion and runoff plots started in 1942 on shallow soil with 1.5 percent slope. I am told that they lose 20 percent of the water by evaporation, 5 percent through the crops, and 15 percent through drainage into the rock. These calculations are obviously in error because they could get essentially no crop with this little water. I am told that they have the least erosion on these plots under peanuts since the plants spread out more than the other adapted crops and break the force of the rain.

I am then taken to a little museum for some more general explanations. I am told that here they have 60 acres of the deep black soil, 60 acres of the medium deep soil, and 59 acres of the light shallow soil. They tell me that unless the fields are very weedy they plow only once in 6 years. Peanut cake and manure increases the yield somewhat. Superphosphate is helpful and boron and manganese

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both give increases with peanuts. They tell me as a general rule the bunding and fertilizer practices all combine to give increases up to 6-fold. They say that contour stripcropping is helpful on slopes up to 3 percent. I am told that now the Department of Agriculture of Bombay State is establishing field demonstrations of these improved practices where the cultivators are guaranteed against any loss.

Because of the erratic climate they expect low yields once in 5 years and crop failure (which means famine) once in 7 years.

There is quite a bit of confusion over the charts.

I had been told earlier that there was rain only in June and Spetember. Now the charts show considerable rain in July and some in August; and according to the experimental plots the most critical erosion period is August, September, and October! The poor fellow trying to explain, Mr. M. M. Kibbe, is having a lot of trouble because Dr. Basu likes to talk and keeps interrupting him. They tell me that the cultivators use some manure and compost but not nearly enough even though these increase yields, especially if they use some ammonium sulphate. Normally they recommend some peanut cake along with the chemical nitrogen. I am told that direct applications of phosphate do not greatly affect the yield of sorghum but do increase the legumes and the cereals grown after the legumes. Kibbe emphasizes again 2- to 3-fold increases with better cultivation, timely sowing, wider spacing (4 pounds of seed against 6 pounds and 18-inch rows instead of 12-inch), and organic matter but with no chemical fertilizer.

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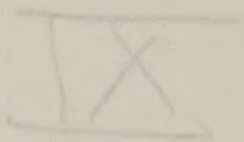
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K-2466. Feb. 2, 1958. Near Sholapur. Harvesting sorghum on dark reddish-brown soil.

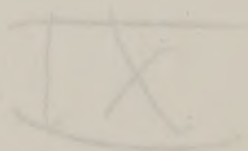


K-2467. Feb. 2, 1958. Agricultural Research Station, east of Sholapur. View of contour bund on rather thin soil. The crop is sorghum; panicum grass started on the bund.



R2466

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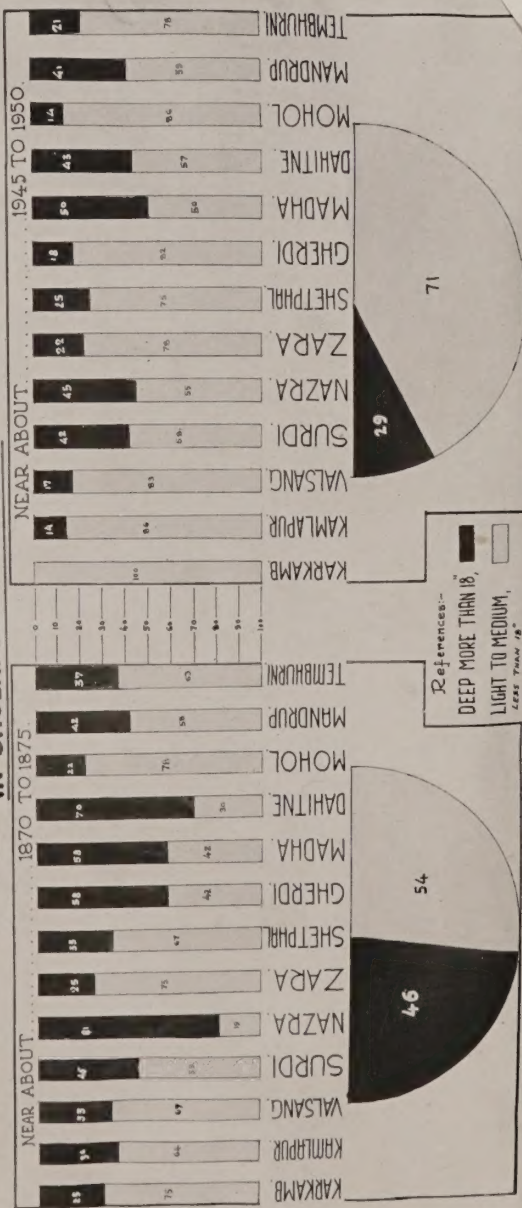


R2467

K-2467. Feb. 2, 1958. Agricultural Research Station, east of Sholapur. View of contour band on rather thin soil. The crop is sorghum; paddy was started on the bund.

**DETERIORATION IN SOIL DEPTH DUE TO SOIL EROSION,
DURING 75 YEARS.**

AREA EXPRESSED AS PERCENTAGE OVER THE TOTAL AREA SURVEYED AT 13 CENTRES,
 _____ IN SHOLAPUR DISTRICT. _____



2014-2015
HIDENBARD, Andrew
INDIA

2014-2015
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INDIA

Then if chemical fertilizers are added to this combination they expect a 4- to 5-fold increase in yield.



This dark brown intergrade between Tropical Black Clay and Reddish Brown or Non-Calcareous Brown. The last one at Sholapur. (R.L.D.)

and are now dealing with saline soil reclamation. There are two sections, agronomy and chemistry. Most of their work is done by the State government. They get very little from the Center although the State of Bombay has from the Center about 15 million rupees for conservation work, soil research, and soil surveys. I notice that there is no cooperation here on the general volume of soil testing, which is a bit odd.

Then if chemical fertilizers are added to this combination they expect a 4- to 6-fold increase in yield.

Their experience shows that strip cropping reduces soil erosion but does not save much water for the crops.

After a brief tea, I try to get some pictures of their various tools, especially the slit hoe.

We leave about 12 o'clock and return to the European rest house where I have a bath, change my clothes and eat lunch. Dr. Basu seems unwell. I suspect a combination of fatigue and dysentery.

About 3 o'clock we go to the soil conservation laboratory at Shetti some 3 miles from the city. This laboratory was established in 1945 to study soil problems and for training. Their main problem was the management and survey of soils used primarily for irrigation. Now they have trainees for soil conservation -- about 100 boys that have graduated from high school, but no B Sc. graduates. They stay here about 6 months for training and then go to work in the villages.

More recently they have started strip cropping at this station and are now dealing with saline soil reclamation. There are only two sections, agronomy and chemistry. Most of their funds come from the State government. They get very little from the Center although the State of Bombay has from the Center about 19 million rupees for conservation work, soil research, and soil surveys. I notice that there is no cooperation here on the general scheme of soil testing, which is a bit too bad.

K-2469. Feb. 2, 1953. Agricultural Research Station east of Sholapur. Tools for sorghum culture. Left to right: Plow, seed drill, harrow to cover seeds, two hoes, two cultivators for use when plants are small.

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K-2468. Feb. 2, 1958. Agricultural Research Station east of Sholapur. View of inevitable runoff plots.



K-2469. Feb. 2, 1958. Agricultural Research Station east of Sholapur. Tools for sorghum culture. Left to right: Plow, seed drill, harrow to cover seeds, two hoes, two cultivators for use when plants are small.

XI

K2468

K-2468. Feb. 2, 1958. Agricultural Research Station east of Sholapur. Tools for sorghum culture. Left to right: Plow, seed drill, harrow to cover seeds, two hoes, two cultivators

XII

K2469

K-2469. Feb. 2, 1958. Agricultural Research Station east of Sholapur. Tools for sorghum culture. Left to right: Plow, seed drill, harrow to cover seeds, two hoes, two cultivators for use when plants are small.



K-2470. Feb. 2, 1958. Agricultural Research Station, east of Sholapur. Tools for monsoon crops of ground nuts, millet, and pigeon peas. Left to right: Plow, harrow, seed drill, two slit hoes, and two hoes for inter-cultivation.



K-2471. Feb. 2, 1958. Agricultural Research Station, east of Sholapur. A slit hoe on white cloth showing the two blades about 4 inches apart at the middle.

III

12470

K-2470. Feb. 2, 1958. Agricultural Research Station, east of Sholapur. Tools for monsoon crops of ground nuts, millet, and pigeon peas. Left to right: Plow, harrow, seed drill, two slit hoes, and two hoes for inter-cultivation.

XII

12471

K-2471. Feb. 2, 1958. Agricultural Research Station, east of Sholapur. A slit hoe on white cloth showing the two blades about 4 inches apart at the middle.

They tell me that they are now starting a "soil conservation" survey: (1) shallow, medium, and deep types; (2) the degree of erosion; (3) soil depth; (4) soil slope; (5) "silt" accumulations.

Since all the soils have been cultivated they have no virgin profiles but they say they can compare the B horizons of the un-eroded and eroded soils. They tell me that soil depth is the only criteria used for determining the major soil types although they insist that color is taken into account in finding the "deep soils!" (These criteria are often inconsistent. Many of the deep soils on the terraces are brown, not black.) The whole scheme is vague and not convincing. They tell me that they are checking their plot and survey results with the old records of 75 years ago made by revenue officers who noted soil depth and soil color. These officers classified 46 percent as "medium deep" and it is now claimed that this figure is only 29 percent.

They think that the original vegetation in the hills was short grass. They believe that any soil with more than 5 percent slope was never cultivated. The evidence is not clear. They tell me that the rivers now carry a lot of "silt" to the sea.

In the laboratory they are measuring the percentage of sodium saturation, Atterberg limits, and mechanical analyses. They insist they are sampling all horizons. As the soil erodes in the runoff plots they get more erosion from the black soils than from the others. This they attribute to the kind of clay, without ever considering the partial erosion pavement, which is very important I'm sure.

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They are also making land classifications for irrigation with 1, 2, 3, and 4 classes that can be irrigated with increasing hazard. Their class 4 has only seasonal irrigation. Class 5 requires leveling and the removal of salts. Class 6 cannot be reclaimed economically.

We again discuss this Kayana soil conservation survey in an area of 350 square miles in the humid mountains. Since the paddy lands on the flat alluvial soils along the river will be mostly flooded by the dams, there is great danger that cultivators will move onto the sloping soils and cause erosion.

I see what looks to me to be a wasteful piece of apparatus, called a rainfall simulator. They are very proud of this expensive, and to me useless, apparatus. The soils under investigation are scooped up in the field and placed as a shallow layer in galvanized pans at various angles. Of course erosion is great since the pan is impermeable and the soil entirely loose. Such an outfit might give some meaningful results on erosion losses from soils in the field, but certainly not under these conditions.

I address the trainees, whose native language is Marathe, and try to explain the principles of soil conservation. I don't know how many of them understand me. I can only hope that their trainers do.

I go back to the rest house and call on Mr. Dodwell, as he suggested this morning, and found no one at home. I have a bit of trouble here communicating with the servants. They have a smattering of British English but apparently not much American English.

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Today I have seen some good work but these boys certainly have a long way to go. They have read almost nothing about soil work in other parts of India and are hardly aware that there is any work in any other tropical area. None of them read French but I am amazed that they are not even familiar with the good work done in the English-speaking parts of Africa.

One is continually impressed with the fact that nearly everything seen here is accomplished by hand labor including all the stone crushing, brick making, much of the weaving, the making of baskets and mats, and so on. But with machines, unemployment would be even worse than it is.

About the time we are ready to go Dr. Basu takes us to the country club so he can greet his old friends. And then on to the railway station at 7:00.

Dr. Basu and I find our compartment, which is not very clean but will need to do.

At the station one sees little bundles of very dirty rags on the platform with sleeping people inside of them. I watch the crowd. I see all types of dress. The common men, and a few higher ups wear dhotis -- sheets from 4 to 5 yards long, wound first around one leg and then around the other. Many have shirts but they wear them with the tails outside. Next comes a kind of pajama pants with a white shirt and the tail out. From that, one sees all conceivable transitions to ordinary European dress. Some wear long coats, buttoned up tight to the collar. A few have shorts

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and sleeveless shirts. Often the garments are mixed, some from the old style and some from another.

The common people are barefoot; the next group have "go ahead" sandals; and finally they take to shoes. But obviously most Indians don't like shoes. Many of the men wear scarves, even on warm days, and some a sari-like shawl. Part of the Indian men wear turbans, others small caps, and many nothing on the head. The Sikhs always wear long hair, a turban, a ring, a knife, and a beard.

Essentially all Indian women wear saris. These vary from dirty ragged white cotton ones to beautiful silk ones, with much gold, over a foundation skirt. I have seen only one Indian woman in European dress. Among the poor women a very dirty white is the predominant color of the sari. Most of the women wear their hair pinned up on their head but a few have pigtails. Certainly if they can, the women have bright colors, or clean white with some bright color, all the way from the cheap cotton to the lovely silk and gold. They are barefooted or wear sandals. Nearly all women have a red dot a bit smaller than a dime on the lower forehead just above the nose; but I notice that a few don't have it. Or they may have a streak rather than a circle. In addition, some have a bright red streak painted in the hair part.

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Many of the poor people wear lots of clothes, even in hot weather, probably because they have no safe place to leave any personal belongings.

There is a great deal of confusion at this station as people come to see me off, including all the trainees. We finally leave for Bombay at 7:55 and I go to bed in the bed roll.

February 4: We are up at 5:00 a.m., after a better sleep than I expected. Fortunately the train is on time and we should leave Bombay as scheduled. Dr. Basu had turned the fan on last night and I find I am getting a slight cold.

We arrive at 8:15 and take a taxi to the air station and check in. We are able to get a little tea and are then in the bus for the airport.

I notice that here in Bombay only some 5 percent of the men wear turbans and about 5 percent the small white caps. There is quite a sprinkling of uniforms for police, guards, peons, car drivers, and so on. A man of some importance has a peon dressed in a red or white suit with a bright red belt and shoulder strap on which there is a big brass medallion with name and office of his master engraved on it.

We reach the airport at 7:45, have another small tea and board the plane at 8:30. We see two dignitaries from Arabia come aboard.

North out of Bombay we pass over hilly land in active geological erosion. The land is quite dry. Accelerated erosion has made some of the soils even thinner. The sloping soils are reddish brown and

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I have a short talk with Mr. Morarji Desai, Union Minister of Commerce and Industry. He tells me that he was born in a cultivators' village. He originally was an officer in Bombay State. We have a nice chat about agriculture and some of the problems. I am much impressed with him.

We come into Delhi at 11:20 a.m. and a Rockefeller Foundation car brings me to the Ashoka Hotel. Dr. Cummings sends all my cases and clothing to my room and we discuss my schedule. Of course, there are several additions.

I begin final work on my report and continue the rest of the day except for an interview with Mr. Pritchard of the Ministry of Food and Agriculture.

I have dinner with Mrs. Wilson and Dorothy Parker.

February 5: The morning is cloudy. Apparently it rained during the night. I work on my report until 11:00 o'clock and have a conference with Mr. Bishaw Mansingh in Dr. Cummings' office. He is a farmer from the UP and has heard about my visit. He argues that some farmers should be added to the soil conservation board. He says the board needs to expand its educational program. He thinks the

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K-2472. Feb. 4, 1958. New Delhi. View from my room in Ashoka Hotel.



K-2473. Feb. 4, 1958. New Delhi. The entrance to the Ashoka Hotel from my room in it.

XII

K2472

K-2472. Feb. 4, 1958. New Delhi. View from my room in Ashoka Hotel.

XIX

K2473

K-2473. Feb. 4, 1958. New Delhi. The entrance to the Ashoka Hotel from my room in it.



K-2474. New Delhi. Workers' homes near Ashoka Hotel.



K-2475. Feb. 5, 1958. New Delhi. Ashoka Hotel.

XIX

K2474

K-2474. New Delhi. Workers' houses near Ashoka Hotel.

XIX

K2475

K-2475. Feb. 5, 1958. New Delhi. Ashoka Hotel.

board should have livestock experts also. He points out that marketing is a great problem and that farmers are at the mercy of the middle man. He proposes something like our soil conservation districts with supervision by the Center rather than by the State. I find myself in agreement with most of his remarks and he seems very pleased.

After lunch I take my draft report and use it as a guide for an oral report to the Soil Conservation Board, with Dr. P. S. Deskmukh in the chair. The membership of the board is as follows:

Dr. P. S. Deskmukh, Chairman

Shri P. N. Thapar, Secretary, Ministry of Food and Agriculture

Dr. B. N. Uppal, Agricultural Commissioner, ICAR

Mr. G. G. Takle, Inspector General Forestry

Dr. R. C. Hoon, Member, Central Water & Power Commission

Mr. K. Sachidanadam, Dy. Secy. (Joint Secretary, Finance)

Nominee of the Ministry of Food and Agriculture, Secretary

Mr. B. D. Kapur, Under Secretary

(And probably there are others).

board should have livestock experts also. He points out that marketing is a great problem and that farmers are at the mercy of the middle man. He proposes something like our soil conservation districts with supervision by the Center rather than by the State. I find myself in agreement with most of his remarks and he seems very pleased.

After lunch I take my draft report and use it as a guide for an oral report to the Soil Conservation Board, with Dr. P. S. Deshmukh in the chair. The membership of the board is as follows:

Dr. P. S. Deshmukh, Chairman
Shri P. N. Thapar, Secretary, Ministry of Food and Agriculture
Dr. B. N. Uppal, Agricultural Commissioner, ICAR
Mr. G. G. Takle, Inspector General Forestry
Dr. R. C. Hoon, Member, Central Water & Power Commission
Mr. K. Sachidanandan, Dy. Secy. (Joint Secretary, Finance)
Nominee of the Ministry of Food and Agriculture, Secretary
Mr. B. D. Kapur, Under Secretary

I am not able to check in detail all of the others present from the Ministry of Food and Agriculture, but I do note the following:

Mr. M. V. Krishnappa, Dy. Minister for Agriculture

Mr. A. M. Thomas, Dy. Minister for Food

Dr. M. S. Randhawa, Vice-President, ICAR

Mr. T. C. Puri, Joint Secretary, Sugar and Forests

Mr. M. Lal, Joint Secretary, Administration (including Foreign Aid)

Dr. J. K. Basu, Director, Soil Conservation (Agronomy)

Mr. M. S. V. Rama Rao, Director, Soil Conservation (Engineering)

Mr. U. S. Madan, Director, Soil Conservation (Forestry)

Mr. Bishan Mansingh

Dr. Frank W. Parker

Dr. Ralph W. Cummings

Mr. W. M. Nixon

Mr. Krishnamurthy of the Central Water and Power Commission

(And probably there are others).

(B. D. KAPUR)

I am not able to check in detail all of the others present from the Ministry of Food and Agriculture, but I do note the following:

Mr. M. V. Krishnaswamy, Dy. Minister for Agriculture
Mr. A. M. Thomas, Dy. Minister for Food
Dr. M. S. Raghavaya, Vice-President, ICAR
Mr. T. C. Puri, Joint Secretary, Sugar and Forests
Mr. M. Lal, Joint Secretary, Administration (including Foreign Aid)
Dr. J. K. Basu, Director, Soil Conservation (Agronomy)
Mr. M. S. V. Rama Rao, Director, Soil Conservation (Engineering)
Mr. U. S. Madan, Director, Soil Conservation (Forestry)
Mr. Bishan Mangal Singh
Dr. Frank W. Parker
Dr. Ralph W. Cummings
Mr. W. M. Nixon
Mr. Krishnamurthy of the Central Water and Power Commission
(And probably there are others).

For Dr. Kellogg's wife

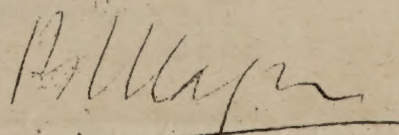
No.1-1/58-Soil Cons.(Pp)tt.)
Government of India,
Ministry of Food and Agriculture,
(Department of Agriculture)

New Delhi, dated the 21st January, 1958.

OFFICE MEMORANDUM.

SUBJECT :- Fourth Meeting of the Central Soil Conservation Board to be held on 5th February, 1958 at 3.00 p.m. in Committee Room No.1.

The undersigned is directed to say that Dr. C.E. Kellogg Assistant Chief of the Soil Conservation Service of U.S.A. was invited through the Rockefeller Foundation to give advice on organisation, planning and execution of Soil Survey in the Country and formulation of integrated Soil Survey Programme for developing proper use and treatment of the cultivators land for Soil and Water Conservation and Agricultural production. Dr. Kellogg arrived here on the 3rd instant and has already met the Members of the Standing Committee and is at present touring different parts of India studying problems of Soil Conservation. The Minister for Co-operation desired that Dr. Kellogg on his return from tour may give his views and recommendations in a meeting of the Central Soil Conservation Board. It has, therefore, been decided to hold a meeting of the Board on 5th February, 1958 at 3.00 p.m. in Committee Room No. 1, (Ground Floor) in the Ministry of Food and Agriculture, under the Chairmanship of Dr. P.S. Deshmukh, Minister for Co-operation. You are requested to make it convenient to attend.



(B. D. KAPUR)

UNDER SECRETARY TO THE GOVERNMENT OF INDIA.

To

1. Shri K. L. Ghei,
Joint Secretary, Ministry of Finance.
2. Shri G. G. Takle, I.F.S.,
Inspector General of Forests.
3. Dr. B. N. Uppal,
Agricultural Commissioner.
4. Shri R. D. Dhir,
Member Central Water & Power Commission, New Delhi.

Copy to :-

1. P.S. to Secretary.
2. P.A. to J.S. (S&F).
3. Dr. S. R. Sen, Economic & Statistics Advisor, Ministry of Food & Agriculture.
4. Deputy Secretary (D).
5. Shri C.A.R. Bhadran, I.F.S.,
Deputy I.E.F.
6. Dr. B. S. Kadam, Agriculture Extension Commissioner,
Dte. of Extension and Training.
7. Dr. R. J. Kalamkar, Additional Agricultural Commissioner,
I.C.A.R., New Delhi.
8. Shri P. R. Ahuja, Central Water & Power Commission, New Delhi.
9. Dr. B. P. Pal, Director, I.A.R.I., New Delhi.
10. Dr. S. P. Raychoudry, Head of the Chemistry Division,
I.A.R.I., New Delhi.
11. Dr. J. S. Patel, Advisor (Agri.) Community Development
Ministry, New Delhi.
12. Shri K. Sachidanandan, Deputy Secretary, Ministry of Finance.
13. Shri Mahabir Prashad, Irrigation Advisor, Ministry of Food
and Agriculture.
14. Dr. J. K. Basu, Director of Soil Conservation (Agri.)
15. Shri M. S. V. Rama Rao, Director Soil Conservation (Engg.).
16. Shri U. S. Madan, Director Soil Conservation (Forests).
17. Dr. T. J. Mirchandani, I.C.A.R., New Delhi.
18. Dr. R. C. Hoon, Director (S.&C.M.) Central Water and Power
Commission (Flood Control), New Delhi.
19. Shri A. D. Desai, Deputy Director of Agriculture, (The T.A.
Govt. of Mysore, Raichur (Mysore State). (and D.A.
20. Dr. R. R. Aggarwal, Agricultural Chemist, Govt. of Uttar Pradesh, Kanpur. etc. if
any will
21. ~~The~~ Central Silviculturist, Forest Research Institute (be borne
and Colleges, Dehra Dun. by Office
22. Mr. W. M. Nixon, T.C.M. Soil Conservation Leader, to which the officer below
American Embassy, Lytton Road, New Delhi.

They are requested to kindly make it convenient to attend the meeting.

Copy forwarded to E.II Section with request to make necessary arrangements for seating and tea etc. About 40 Officers will attend the meeting.

B. D. Kapur

(B. D. KAPUR)
UNDER SECRETARY.

'Sharma'

This is quite strenuous exercise since I explain and emphasize all the points dealing with soil conservation and training, and some of those dealing with the soil survey, that I have in the draft report. (The completed report is included at the end of this volume.)

After a short visit with Mr. Nixon and Dr. Cummings we go to tea chez Mr. M. S. B. Rama Rao, Director of Soil Conservation for Engineering. Here again I meet several people that I have been working with during the last few weeks. Then with several of my ^{given} American friends I go to a dinner/by Dorothy Parker in old Delhi. This consists almost entirely of one whole roast chicken. No knives or forks are set at the table and we eat Indian style with our fingers. After the dinner I go back to my hotel very tired, and to bed at 10 p.m.

February 6:

I am up fairly early in order to finish my speeches for the next three days.

At 9 comes Mr. Krishnamurthy of the Water and Power Commission. He had raised a few questions about our program in the Soil Conservation Service yesterday and had asked for a brief conference. He was on a study tour in the United States a few years ago and spent all of his time with the Corps of Engineers and the Bureau of Reclamation. He saw nothing of the program of the Soil Conservation Service and had not realized the work we were doing on small watersheds. I have a good talk with him about our program and answer a list of questions that he had prepared in advance. For many of these I suggest that he write directly to our Watershed Planning Branch in Washington for copies of the laws, regulations, and handbooks.

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February 6: Thursday

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No.31-2/58-Soil Cons.(Instt.)
Government of India,
Ministry of Food and Agriculture,
(Department of Agriculture)

New Delhi, dated the 23rd January, 1958.

OFFICE MEMORANDUM.

SUBJECT :- 4th Meeting of the Standing Technical Sub-Committee of the Integrated All-India Soil and Land Use Survey Scheme.

The undersigned is directed to refer to this Ministry's Office Memorandum No.30-8/57-Soil Cons.(Instt.), dated the 17th January, 1958 forwarding the minutes of the 3rd meeting of the Standing Technical Sub-Committee of the All-India Soil and Land Use Survey Scheme and to say that the fourth meeting of the Sub-Committee will be held on 6th February, 1958 at 11.00 A.M. in the Committee Room No. II in the Multi-storeyed Building Queen-Victoria Road, New Delhi and not at 3.00 P.M. as mentioned in the minutes referred to above.

2- Dr. C.E. Kellogg, Assistant Chief of the Soil Conservation Service of U.S.A. who is at present touring the country, will give his views on the technical aspects of Soil Conservation Survey. You are therefore requested to make it convenient to attend the meeting.

3- The T.A. and D.A. etc., if any, will be borne by the Office to which the Officer belongs.

B. D. Kapur

(B. D. KAPUR)

UNDER SECRETARY TO THE GOVT. OF INDIA.

To

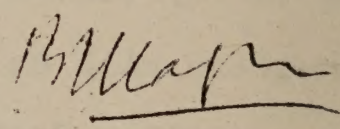
1. Dr. R.C. Hoon, Director (S&C.M) Central Water & Power Commission (Flood Control), New Delhi.
2. The Central Silviculturist, Forest Research Institute and Colleges, Dehra Dun.
3. Dr. S.P. Raychaudry, Head of Soil Science, Indian Agricultural Research Institute, New Delhi.
4. Dr. R.R. Aggarwal, Agricultural Chemist, Govt. of U.P., Kanpur.
5. Dr. A.D. Desai, Dy. Director of Agriculture, Government of Mysore, Raichur (Mysore State).
6. Dr. T.J. Mirchandani, I.C.A.R., New Delhi.
7. Mr. W.M. Nixon, T.C.M. Soil Conservation Leader, American Embassy, Lutton Road, New Delhi.

F.T.C.

Copy forwarded to for information :-

1. P.A. to Joint Secretary (S & F).
2. Deputy Secretary (D)
3. Agricultural Commissioner, I.C.A.R., New Delhi.
4. Inspector General of Forests.
5. Deputy Inspector General of Forests.
6. Director of Soil Conservation (Agriculture)
7. Director of Soil Conservation (Engineering)
8. Director of Soil Conservation (Forests).
9. Under Secretary (S).
10. Dr. B.P. Pal, Director, Indian Agricultural Research Institute, New Delhi.
11. Dr. F. W. Parker.
12. Dr. R. W. Cummings, Director, The Rockefeller Foundation, Asoka Hotel, Room No.107, New Delhi.
13. T. A. Section.

Estt.II Section with the request that necessary arrangements for seating stationary and Coffee etc. may please be made for about 20 persons.


(B. D. Kapur)
Under Secretary.

This is followed by a brief conference with Mr. U. S. Madan, Director of Soil Conservation for Forestry. In the group he talks very little and very jerkily. In my private conversation with him he is under less nervous strain and we have an excellent discussion of the main problems and opportunities for forestry in a soil conservation program directed chiefly at agricultural communities. He agrees with me that strictly forest work in large holdings could best be handled by the Forest Service rather than by the Soil Conservation Board; but we do agree that forestry has a big place in the villages, mainly for fuel, charcoal, food crops, living fences, and items of that sort rather than primarily for ordinary timber production.

About 10 a.m. I go to a meeting of the Soil Survey Committee where I present my recommendations for that part of the program. These are also included in the report that comes near the end of this Journal. Dr. Basu acts as chairman and I talk to essentially the same group that I talked to shortly after my arrival on January 7. In addition, I see Dr. Sen from the DVC, Dr. Agarwal from Kanpur, and several others besides the Americans working directly with me.

I think these recommendations are a bit too strong for some of them. The State people like Dr. Agarwal are not convinced entirely that the Center should have soil mappers on its payroll. Dr. Raychaudhuri is skeptical about my recommendation of switching the administration of the Soil Survey from the Indian Agricultural Research Institute to the Soil Conservation Board. I think he is also doubtful about my strong recommendation for having the soil maps printed by the Survey of India. I point out to them, as I did to the other group,

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that I know perfectly well that there is no single way to organize soil survey work or soil conservation work. This is obvious because successful soil surveys are organized quite differently in several countries. On the basis of what I have been able to read and to see in India, I am trying to give them the best judgment of which I am capable and explain the way that I believe would be most efficient in terms of operations, of timing, and of expenditure. I know that part of the people still have some doubts. And I expected this because several of them have been working in quite different ways.

I then go back to the Ashoka Hotel to be the principal guest at a very fine luncheon given for me by Dr. P. S. Deshmukh. He seems like a very fine man indeed and is particularly interested in my recommendations regarding cooperation between the soil conservationists and extension people and the working out of schemes for the cultivators in the villages to have definite responsibility in the work. This luncheon was attended by most of the leading men of the Ministry of Agriculture, together with some from other ministries.

After lunch I go back for a final reading of my report, which is now being mimeographed. I correct these mimeograph sheets as ^{to} they are typed until 5:30 when I go/have tea chez Dr. J. K. Basu. Here again I meet many of the Indians and Americans with whom I have been working. Very nice. I return to the hotel. I am just a bit hesitant to accept a gift from Mrs. Cummings, which is a duplicate of a brightly colored bedspread, representing the "tree of life," that I admired at her house. But she assures that the gift is not for me but for Mrs. Kellogg, and so I weaken.

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To meet Dr. C. E. Kellogg of the U. S. Deptt. of Agriculture



Dr. P. S. Deshmukh,
Minister of Cooperation,
requests the pleasure of the company of

Shri Dr. C. E. Kellogg

at Lunch

on Thursday, the 6th February 1958, at 1-15 p.m.
at Ashoka Hotel, New Delhi

R.S.V.P.

Private Secretary.
Tel. No. 45011/18.

*Mr. Frank Forbes
requests the pleasure of the company of
Mr. Kellogg
at dinner
on Friday 7 February
at 8 o'clock*

Dr. C. E. Kellogg.

To meet Dr. C. E. Kellogg

Dr. J. N. Mukherjee

AT HOME

on Wednesday, 29th January 1958, at 5-30 p.m.

at 2 Old Mill Road

R. S. V. P.
2 Old Mill Road
New Delhi
Tel: 44799

Dr. & Mrs. J. K. Basu

request the pleasure of the company of

..... Dr. C. E. Kellogg

at Tea

on Thursday, 6th February at 5.30 p.m.

at 10, Shan Nagar

R. S. V. P.
10, Shan Nagar,
New Delhi.

Farewell to Dr Charles E Kellogg

Mr Frank Parker

requests the pleasure of the company of

Mr Kellogg

at Dinner

on Friday 7 February

at 8 o'clock

R. S. V. P.
40, Golf Link Road
Second Floor

Reminder

I have an early dinner with Mrs. Wilson and go to bed very tired indeed. The cold I picked up in the early morning at Bombay has now turned into laryngitis.

February 7: Again I have no sleep after 5 a.m. partly because of this cold. I sort out all my many bulletins, reports, maps, and statements into a bundle that will be sent home by surface mail and one that will be sent by air. Then breakfast.

At 10 I have a conference with Mr. Douglas Ensminger, who is in charge of the work for the Ford Foundation here in India. We have a nice conference and agree fairly well on what needs doing. Like Mr. M. L. Wilson, he places a very high priority on the need for price supports to give the peasant some assurance that if he increases production he will be rewarded for it.

At 11 I have a pleasant conference with Shri B. T. Krishnamachari, vice-Chairman of the Planning Commission. This is probably the most important branch of the government. Since Mr. Nehru himself is chairman of the Commission, a large part of the responsibility falls on the vice-chairman.

We go over together many of the main items in my report and discuss the relationship of these items to the other facets of agriculture, including agricultural credit, price stability, risk insurance, and so on. I point out that there is considerable wasteland for only institutional reasons which could be used for crops. I give my judgment as opposed to any kind of rigid ceiling on the number of acres that an individual farmer could use. I had been told

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that Mr. Nehru is very strong on this point and ^{is}/talking a great deal about a 30-acre limit. I emphasize all I can that this would lead to a mediocre peasant agriculture. It would amount to one set of rules for people in the city and a very different set of rules for people in the country. This I feel would be unreasonable and unfair. I don't believe that he had looked at it this way before. I go on to explain that the government should protect itself against landowners holding land in low intensity use or practicing bad husbandry. But I insist that putting an arbitrary ceiling on the total acreage is not the way to do it. I suggest using something like the British system (only I don't call it that) of rating farmers according to their demonstrated use of the land. Those who do poorly are given warnings and extra extension help. If they fail to improve they are removed and another able manager put in place. I explain that where this has been done very few farmers have had to be removed. When they know the government means business they sell part of their land, or all of it, get another manager, or do whatever is necessary. The implied threat in this kind of regulation accomplishes the purpose. Possibly some upper limit should be set but if so it should be high enough to permit the enterprising farmers who have skill and who want to be able to operate with full use of modern machinery and chemistry to do so. I know this makes quite an impression on him but whether he is convinced enough so that he, in turn, can convince Mr. Nehru is another matter. Dr. Raychandhuri gives us a very nice album of photographs during our trips together. I am in bed at 11 o'clock.

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I enjoy my conference with this man very much. I am tremendously impressed with his sincerity, his ability, and his grasp of the problems in agriculture.

I return to the hotel for a brief rest and some treatment of my throat and go at 5:15 to the Institute of Engineers for tea and for a considerable lecture on soils and engineering. In this lecture I explain what I mean by "soil" and by "soil conservation." I try to show the intimate relationships between soil and water and list on the board the most important single items, such as irrigation, drainage, highways, and so forth that are the direct responsibility of engineers. But the point is that for these to be effective they must be properly related to the kind of soil, the plants, the cultivators, and to one another. This I illustrate by several examples from irrigation and drainage, runoff and erosion, large reservoirs and the practices used in the watershed, and so on. I give particular emphasis to the great stimulation of erosion in India by bad highway planning and the very bad effects of shallow borrow pits for highway grades and high canals. I close with an explanation of the very serious soil deterioration in India due to the shallow excavations in good soil for brick material.

This long talk is pretty rough on my throat. From there I go to have dinner at the Parkers. This is a stag affair with the American and Indian officers most directly concerned with soil research, soil survey, and soil conservation. Dr. Raychaudhuri gives me a very nice album of photographs during our trips together. I am in bed at 11 o'clock.

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February 8: I am up at 6:30 and do as much packing as can be done now.

A little before 10 a driver picks me up and we get Dr. Basu and go to the office of the Prime Minister. At the last minute I discover that Dr. Basu doesn't know where this office is. By a good streak of luck we meet a general in the army who knows Dr. Basu and helps us find it.

After a few minutes we are taken into the office of the Prime Minister. He rises from his desk and meets and greets us at the door. He is obviously tired and, like me, he has a cold.

We talk about the problems of soil conservation and need for a broad point of view of its many interrelated facets. I explain how water control and fertilizers are intimately related to support one another.

He asks about fertilizers and we talk about the relation of recommendations to the soil maps that are being planned. He is concerned about the arguments he has read of organic fertilizers instead of chemical fertilizers. I hope I am able to straighten him out on this question, which seems to be so difficult for so many laymen. I emphasize the need for village forests wherever there is an opportunity in order to give the cultivators fuel so that they may preserve the animal manures for crops. Then he raises questions about minor nutrient deficiencies. I point out the value of animal manure and compost but that through science we can supply many of these minor nutrients and correct deficiencies more economically with chemicals.

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door. He is obviously tired and, like me, he has a cold.

We talk about the problems of soil conservation and need for

a broad point of view of its many interrelated facets. I explain

how water control and fertilizers are intimately related to support

one another.

He asks about fertilizers and we talk about the relation of

recommendations to the soil maps that are being planned. He is

concerned about the arguments he has read of organic fertilizers

instead of chemical fertilizers. I hope I am able to straighten

him out on this question, which seems to be so difficult for so

many laymen. I emphasize the need for village forests wherever

there is an opportunity in order to give the cultivators fuel so

that they may preserve the animal manures for crops. Then he raises

questions about minor nutrient deficiencies. I point out the value

of animal manure and compost but that through science we can supply

many of these minor nutrients and correct deficiencies more economically

with chemicals.

Fortunately I can talk to him about the work done along this line in India that I had seen in Bombay State.

After about 20 minutes I feel that we might outstay our welcome so I excuse myself. Again he is very gracious, thanks us, and follows us to the door.

Dr. Basu goes back to the hotel with me and talks a good deal more about personal business opportunities that might be available to him. About this I can have little to do.

Then I go to the Indian Agricultural Research Institute and talk to the Pusa Agricultural Society - the same group that I lectured to when I first came. Thank goodness this is my last speech! I talk about research in soil conservation in India and the many opportunities that I think they have. This time I can illustrate my remarks with examples from many parts of India itself. I argue for a broad point of view including the very important relationships among the consolidation of holdings, the control of water, the use of fertilizers, the improvement of seeds, and so on. I think it goes very well and I have no feeling of being tired until its over. Then my throat really tightens up.

Again I am back to the hotel for lunch with the Cummings and Parkers. I complete my packing and have tea with Mr. and Mrs. M. L. Wilson.

Dr. Cummings takes me to the airport. When I get there I find the Parkers, the Nixons, and many of my Indian friends who have come to see me off with many garlands of flowers and good wishes. I bungle through customs, very hoarse and tired. My plane comes in an hour

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late so I have plenty of time for chitchat and farewells.

I get into the plane at 8:30 and we leave at 8:40 Delhi time. There is no berth. How I dread this long flight with all the many stops!

We are down at Karachi at 11:12 p.m. Karachi time where we have a long dull wait, as one day changes to another.

February 9: We leave at 12:36 a.m. and are down in Baghdad at 4:44 local time. Although we are still late the staff seems to be indifferent and we do not leave until 5:47.

This BOAC aircraft is new but poorly designed. For example, the lights do not coordinate with the seats. The electric outlets in the toilet room are for English razors, which are 220 volts, but the electricity is 110 volts, which is used for American razors. Thus, they have made^a/compromise and got a combination of outlet and current that won't fit either one. But it is not too bad; the plane carries a special razor with an American motor and an English plug.

As we approach Beirut, the pilot does a lot of turning, I suppose to conform to some regulation. The mountains here have a thin to medium cover of snow; otherwise they are nearly barren.

We are down in Beirut at 6:40 and leave at 7:50, local time. These British crews are certainly slow and indifferent about their schedules.

As we fly along I have a good view of Athens and Mt. Olympus.

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We are down in Rome at 11:25 a.m., practically on time.

Dr. and Mrs. Ignatieff meet me at the airport and hasten me to their home. My throat is exceedingly hoarse. Mrs. Ignatieff gives me some gargle and we have a nice visit until 8, when I go to bed.

February 10: I am up at 6:30 for tea and breakfast; and then Mrs. Ignatieff and I go to the city for shopping. And I do. I buy two hats for myself, 6 pairs of gloves for my ladies, one pair of gloves for myself, cuff links, an ash tray, two ties, and a nice painting by a young Florentine artist. After this money-spending spree I go to lunch in FAO with Dr. and Mrs. Ignatieff.

I go back to the apartment for packing and then return to FAO for conferences with Dr. Blackmore, Dr. Wahlen, and others.

About 5:15 Mrs. Ignatieff brings my baggage and we all go to the airport where we have tea and chat until my plane is called.

I am in the air about 6:45 and down again in Paris at 9. We need to wait here nearly two hours. We are in the air again at 11:02 Paris time for New York. Fortunately on this plane I have a sleeper so I go almost immediately to bed. One day passes into another.

February 11: I am up about 9 a.m. Paris time which is 3 a.m. New York time. Fortunately we shall come in nearly two hours early because of a strong east wind. I clean up and make out my customs declaration. We are over Boston at 4:45 a.m. (but nobody is around).

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The wheels are down at Idlewild in New York at 5:30 a.m. Then I wait and wait for baggage. Something apparently was done wrong in Rome and they can't open the baggage hatch so that the plane needs to be wheeled into the hangar in order to get at it from the inside. What a terrible wait when one is so tired. The baggage comes at 7:40 a.m., and I am through customs in a hurry. I have been given directions to go to the National Airlines desk for a plane leaving at 8:40. The crowd is terrific. At the National desk they tell me that their plane is very late and I should transfer to Eastern. I hurry to Eastern, which is a long way off, with all these bags and just as I get there they tell me that the plane has gone. So I go back to National. Then I am told that I could have gone by American at 8:45 a.m. This is one of the most poorly organized places I have ever been in.

I get on a little plane at 9:40 but it is obviously not ready. After all the people are on the plane, the baggage and freight are loaded. I am convinced that these people need some technical advice from India on how to manage air travel and air stations. Certainly at no place did I see such bad management and such complete indifference to the public. Meanwhile we wait while the crew loiters. I hope I will never have to go on this airline again.

At last we get out on the runway with 3 planes ahead of us, not counting 2 coming in. This trip is becoming more ridiculous by the minute. I resolve that hereafter I shall go to the city and take the train to Washington.

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We are finally in the air at 10:23. Thus I cannot expect to reach Washington much before noon although I arrived in New York at 5:30 a.m.

When we reach Washington the plane circles several times but is finally down at 11:40.

Here I am met by Mrs. Kellogg. To my great joy and relief she drives me home again.

SOIL CONSERVATION AND SOIL SURVEY IN INDIA

by CHARLES E. KELLOGG

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This report was prepared by the author during a five-week visit to India in January and early February, 1958 on request by the Government of India to advise with the National Soil Conservation Board on Soil Surveys and Soil Conservation Programs. Mr. Kellogg's visit to India was arranged through the assistance of The Rockefeller Foundation.

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The suggestions that follow were formulated after study of several documents about the current soil programs under way, conversations with many people in India, and short visits to a few locations. The limited time for detailed field work, study, and reflection must be recognized.

Since soil conservation and soil surveys are intimately related together and with other soil and agricultural research, and with plans for irrigation, drainage, and flood protection, it is not possible to deal adequately with any one aspect separately from the others. For ease of presentation, I have grouped those items pertaining mainly to soil survey under one general heading, those relating to the soil conservation under another, those relating to technical training under a third, and the status and recruitment of soil scientists and soil conservationists under a fourth. But this division is somewhat arbitrary since the whole purpose of the training and of the soil survey is to achieve soil conservation in the broad sense of using the kinds of soil available in India at the highest economically feasible level of sustained production with whatever combinations of practices and materials are available for use.

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SOIL SURVEY

A. The Survey of a tentative long term (5 to 10 years)

1. For reasons of economy and effectiveness, and to make full use of the small number of soil scientists trained to carry out field work, it is strongly recommended that one standard soil survey (with varying scales of mapping and detail of classification as required) be developed cooperatively by the Center and the States to serve all users. These include soil conservation irrigation, agricultural extension, consolidation of holdings, catchment basement planning, afforestation, grazing land development and guarding, and the like. It is entirely feasible to develop one standard soil survey that can be used and understood by all. Having separate soil surveys, as now, by the Center, by individual States, for soil conservation planning, and for developing irrigation is bound to lead to unnecessary duplication, confusion in terminology, and misunderstandings among both the field scientists and the users of the results.

Once a standard soil survey is available, either from copies of field sheets or from publications, all classes of users can have the specific interpretations from it for their immediate purposes.

Such standard soil surveys should take into account all soil characteristics that are significant to the various uses. The soil classification and mapping should be objective. If instead, interpretations are mapped rather than the soils themselves, the maps are likely to be useless for other interpretations and are very likely to go out of date rapidly. The interpretations change with changes in the agricultural arts and in economic and social conditions. But once an objective standard soil survey has been made, it can be interpreted for all classes of users and these interpretations can be revised as conditions change with little or no additional expense for costly field work.

2. It is recommended that a memorandum of understanding be drawn up to cover the objectives and plans for cooperative soil surveys between the Center and each State in full consultation with the representatives of all major using agencies of the Government of India and of the States. Where special organizations are operating, such as the D.V.C., three-way memoranda should be developed to include the three agencies making and using the survey.

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(5) The interpretations to be made of the soil survey.

The memorandum should provide for following additional documents to be prepared:

A. The development of a tentative long term (5 to 10 years) plan of areas to be taken up for soil survey in accord with priorities as required to give the greatest possible service to planned developments dealing with soil conservation, irrigation, consolidation of holdings, watershed protection, and the like. Surveys in advance of these developments should be emphasized since they play a very large role in the ultimate outcome of heavy public expenditures. These long term plans should be revised annually as developments proceed and conditions change.

B. A firm annual plan should be developed each year, preferably at a fixed date, for the soil survey work to be undertaken. This plan should include specific boundaries of the areas to be surveyed and the personnel transport, supervision, laboratory work, research on the soils, cartography, and interpretation of the soils for use. The names of the scientific officers and the specific functions and the contributions of each cooperating agency should be written into this annual plan. With full co-operative work of high priority, personnel from two or more agencies may be working as a soil survey team under the guidance of one specific individual as party chief.

C. A specific work plan should be prepared for each soil survey project. It should be signed by the responsible officer of each cooperating agency so that no misunderstandings will arise about intentions. This work plan can be amended, formally, if conditions change during the course of the survey. The work plan is very important because some soil surveys may continue for three or four years during which there may be important changes in administrative personnel in the agencies. The work plan should provide at least the following:

- (5) Plans and contents of (a) the tentative report or hand (1) Objectives and uses to be expected of the interpretations for immediate soil maps and reports the field sheets and (b) the final report for publication. As soon as the soil survey (2) The planned contributions of personnel and descriptive facilities of each cooperating agency the map and a description of each unit as mapped. As the work progresses (3) The names of the scientific officers and of the immediate supervisors and cooperators that are needed by the map users. This expanded descriptive legend (4) The scale of the soil map - 1:10,000. It can be tested in the field by those using the results, criticized,
- i) For field work
 - ii) For publication

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- (1) Objectives and uses to be expected of the soil maps and reports
- (2) The planned contributions of personnel and facilities of each cooperating agency
- (3) The names of the scientific officers and of the immediate supervisors and cooperators
- (4) The scale of the soil map

(5) The interpretations to be made of the soil survey.

These interpretations may take the form of tabular ratings or index numbers, or they may take the form of groupings of the kinds of soil (types and phases) shown on the map and described in the legend. In most agricultural areas a great many interpretations can and should be made for use by agriculturists, foresters, engineers, and others. Examples of such interpretations include the following:

- i) The estimated average yields of the adapted crops under each specific system of management important to each mapping unit.

Note: The harvest from any soil results from the nature of the soil and the combinations of practices in the management system. Commonly there are several alternatives and yield estimates are needed for each significant alternative in order to give the cultivator a choice.

- ii) Erosion hazard. Commonly soils can be grouped into about five classes in accord with degree of erosion hazard under clean cultivation.

- iii) Soils can be grouped into capability units (or management groups) that bring together those kinds of soils that have approximately the same potentialities and management requirements for high sustained use under soil conservation. These may be further grouped into capability classes in accordance with their general potentiality and the hazards and limitations of use for the common agricultural crops.

- iv) Suitability of the soils for various species of productive trees (forest site index).

(6) Plans and authors of (a) the tentative report or handbook containing the soil descriptions and interpretations for immediate use with copies of the field sheets and (b) the final report for publication. As soon as the soil survey is initiated, it is important to have a descriptive legend that gives the mapping symbol on the map and a description of each unit as mapped. As the work progresses and data are accumulated, the individual soil descriptions can be supplemented with interpretations that are needed by the map users. This expanded descriptive legend serves as a handbook of the soils. It can be tested in the field by those using the results, criticized,

1" = 1 mile is far too small for ready use by extension officers, soil conservationists, or conservation engineers.

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and perfected. At the close of the soil mapping work, this handbook forms a basis for the preparation of the published report. In this way there is always available a text that can be reproduced for using the soil maps from the time the survey is initiated until its final publication. Of course, such handbooks are revised during the course of the survey.

D. Following the development of the work plan for an area, the soil survey party leader, under the technical guidance of the soil correlator and of his immediate superior, should prepare an initial review of the area that includes a suitable legend of the kinds of soil, such as types and phases, in order that the soil survey can be carried out in a way to accomplish the objectives of the work plan.

Normally, one does not find all the soils during this first review. As the work goes forward the soil correlator and other representatives of cooperating agencies should go over the survey together and make progress reviews to check the adequacy of the legend, the accuracy of the mapping, and the soundness of the interpretations. Finally, as the survey is finished the same officers make a final review with recommendations for the names to be used in the final map. These names should be subject to review at the Center to avoid confusion or duplication.

3. A. It is recommended that the All-India Soil Survey give its main emphasis to detailed standard surveys on village maps ($16'' = 1$ mile or $8'' = 1$ mile according to the detail required), supplemented where possible by aerial photographs ($8'' = 1$ mile), with overlap to permit advanced study of the area under the stereoscope. In many countries, including the United States, essentially all soil mapping is done directly on aerial photographs. But most of these countries do not have these $16'' = 1$ mile village maps. The individual holdings are so small in many of the villages in India, and it is so important that the soil boundaries be accurate in respect to these individual small holdings, that I believe it is better to use the village maps for plotting the boundaries than to use the air photographs unless there is found to be a cheap and practical way to transfer the boundaries of the holdings to aerial photographs of large scale. For publications, these field maps can be reduced to a scale somewhere between $2'' = 1$ mile and $4'' = 1$ mile according to the detail on the field sheets and the uses to be made of the published soil map. In most agricultural parts of India a soil map on a scale of $1'' = 1$ mile is far too small for ready use by extension officers, soil conservationists, or conservation engineers.

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Field sheets should be reproduced directly by the cheapest process for use by all those officers working directly with land development or with the cultivators on soil and water management and conservation.

In this way the soil maps will be accurate in relation to the boundaries of the cultivators' fields. Smaller scale field sheets are not likely to be usable in direct work with specific cultivators, which is by far the outstanding present need of soil maps in India.

B. It is recommended that field soil maps of small scale, say less than $4'' = 1$ mile, be made under only two situations:

(1) Where there is urgent need immediately of a general or schematic soil survey in advance of planning a land development project, say for new irrigation or land reclamation by clearing, in order to locate the most promising areas that should be mapped in greater detail, in order to develop new or revised fields, canals, and other works of improvement, and for soil conservation planning. In planning watershed protection such preliminary soil maps may be made in order to locate quickly the most critical areas producing the silt that goes into the reservoirs.

(2) In non-farm areas of rough grazing or woodland where the needs for conservation planning, afforestation, and controlled grassland developments can be met by a map of small scale.

4. It is recommended that the All-India cooperative soil survey program be continued and gradually expanded on a relatively modest basis in areas of high priority. The program should not be expanded beyond the availability of trained soil scientists who can direct the local field work in ways that produce reliable soil maps and interpretations. An over expansion beyond the availability of trained personnel would certainly lead to unreliable results and costly failures.

5. It is recommended that further trials be made of using diploma holders as field workers under the direction of trained soil scientists in order to cover as much land as possible at low cost consistent with accurate results. As is already being done in a few places, the party leaders can lay out grids, or lines, on the village maps for such men to follow. On these lines he can indicate the spots for examination of the soil profile and the measurement of soil slope. Descriptions need to be in strictly objective terms, in writing, on an appropriate outline. From these orderly notes a tentative soil map can be drawn by the

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party leader which he then corrects and completes in the field by observing all the soil boundaries throughout their courses.

In some places now in India, such workers map only soil slope and soil depth as a basis for laying out bunds. They can be trained also to map the soil types and thus have a soil survey for all purposes.

6. Soil correlation should be directed during the next three or four years to obtaining uniformity of soil descriptions (according to the Soil Survey Manual or other appropriate handbook) so that soils can be compared and later correlated as soil types (and phases of soil types), with a uniform nomenclature throughout India. But before country-wide soil correlation can be attempted soil descriptions need to be on a uniform basis and many soils described within the areas that are mapped in detail. In these local areas mapping units should be soil types with any necessary phases for soil slope; salinity; truncation by erosion or excavation; gullying; stoniness; depth to the water level; hardpan; or rock; and so on. It should be emphasized that each phase of the soil type must be included within the definition of that soil type, and that the definitions of phases within different soil types may not be uniform. For example, some soils are highly erosive at 1% slope. With those soils a line should be drawn to separate those soils above 1% slope from those below it. In other soils, erosion is not serious until one reaches 5 or perhaps 7 percent slope. For those the line should be drawn at that appropriate percentage of slope.

During this initial period, the four soil correlators should take a few well-planned field trips together and with the appropriate State soil scientists to be sure that they are describing similar soil characteristics alike.

7. It is recommended that the four areas for soil correlation be revised from the present basis and be established as four groups of States so that each soil correlator works with all the soils in his assigned region. The suggestion of soil correlation by broad soil regions is absolutely certain to involve unnecessary overlapping travel and administrative confusion. To take one example, Alluvial soils are found throughout India.

8. It is recommended that simple cartographic services be supplied at regional centers or at State centers, as convenient, and as agreed on in the memorandum of understanding, and that final map compilation be at the same places or at the Center according to available facilities and cost.

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12 Reproductions of field sheets and of compiled manuscript maps for immediate use in the field should probably be done at the Center in order to conserve equipment.

9. It is recommended that every effort be made to work out arrangements for the Survey of India to make the necessary color separation plates for colored soil maps and to print all soil maps to be published. Considering the relatively low volume of work for publication during the next few years and considering the high engineering skill required, it would be very costly indeed for the Center to support the staff and equipment required for making color separation plates and for printing soil maps.

10. At the Center headquarters of the soil survey, a skilled cartographer on the soil survey staff should serve as liaison with the Survey of India. He should supervise the reproduction of field sheets and such compilation of soil surveys as is undertaken at the Center. He should be responsible for seeing that each survey project leader in India has copies of all available cartographic materials, including aerial photographs of appropriate scale, all available topographic maps, geological maps, cadastral maps, and all other maps of the soil or land, vegetation, land use, and climate. As soon as a work plan is being considered it should be called to his attention immediately so that these materials may be gathered because the availability of such materials has an important bearing on priorities and on the development of the most efficient work plan for the survey.

11. It is recommended that a highly qualified, well-trained officer be assigned on the staff of the Director at the Center to promulgate methods for interpreting the soil classification and the soil maps in terms of suitability for adapted crops, trees, and grasses under alternative systems of management for each kind of soil, and for the many groupings of soils needed in land development programs. Such groupings include: arability under irrigation, erosion hazard, capability groupings, arability of soils with drainage or flood control, general fertilizer requirements, engineering properties in respect to water disposal, road construction, and the like, and the many uses of the soil survey in various types of land classification. This officer needs not only field experience in the soil survey, but also training in agronomy, horticulture, and economics. Under this officer should also be included the final technical editing of the soil survey publications being prepared in the field and reviewed by the regional correlators.

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12. It is recommended that the Center have a highly qualified staff officer to carry out and supervise the carrying out of the specific researches necessary for understanding soils that are to be classified and mapped. That is, in some survey areas, preliminary research is often required in order to develop a practical legend. These researches include both field studies in soil morphology (and related ecology, geology, and geomorphology) and combined laboratory and field researches. The laboratory should be under this officer and should be a national one responsible for methods and for standardized determinations made in the field laboratories under the regional leaders. As a general estimate, somewhere between five and ten percent of the soil survey funds will be required for these field researches and for the laboratory work. For example, researches are often needed to find just where to separate soil types from one another according to permeability of the subsoil in order to recommend contour terraces or graded terraces and the kinds of rotation. Similarly, field research is necessary to establish slope phases at the proper place. Many other examples could be given where research must either precede or go along with the development of a soil survey legend that will give soil maps that can be interpreted in terms of specific practices. Further, unless the genesis of the soils is clear, the boundaries are not likely to be drawn accurately.

13. It is recommended that a well-trained geomorphologist be added to the staff at the Center, probably under the Director of Soil Survey Research, in order to give training in this important field to the soil correlators and especially to the soil survey party chiefs. In any old tropical landscape there have been many changes in climate and many erosion cycles. Rarely are soils in tropical areas actually developed in situ from the rocky materials deep below. Most of the surface materials have been moved about many times. An understanding of these geomorphological processes, and their evaluation, are important in order to assess the significance of the various layers seen in the soil section and to predict erosion hazard.

14. Priority of surveys should be given great emphasis. The soil survey program in India can be developed only gradually over a period of years. No whole country can be mapped at once. Thus, the All-India Soil Survey will have the critical problem of establishing priorities for taking up publishable units of survey. Normally, a convenient size is about 2 to 5 lakh acres. It is also convenient in the use of the surveys to have important local governmental units included within one survey.

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17. It is recommended that these priorities be worked out in cooperation with the States at a high level in the Government of India so that the needs of all agencies using the results can present their views. Following are the chief items to take into account:

A. It is of first importance to emphasize soil surveys in those areas where the greatest possibility exists for substantial improvement in agricultural production and efficiency. In this way, the soil survey can begin at once to have a direct effect on incomes of both cultivators and the government. The excellent work done in parts of India along this line can be seen. One example has been the improved yields and efficiency of sugarcane growing in Bombay State. Such results can be had all over the country with all crops.

B. The plans for land development and conservation schemes should all include detailed surveys in advance to ensure economy and effectiveness. This is specially urgent (a) for public works of considerable cost and (b) where cultivators are expected to make substantial changes in their farming systems.

C. Plans should give emphasis to extension work in the various parts of the States, especially plans for the consolidation of holdings and for village improvement.

D. As early as practicable, detailed soil surveys should be made in each significantly different kind of soil region so that the general scheme on soil classification for all of India can be developed as soon as practicable.

E. The availability of existing cartographic materials, including aerial photographs and geological maps should be considered. Other things being equal, preference should be given to those areas already having such maps.

15. It is recommended that the soil survey establish cooperative relationships with existing agencies for special assistance in agronomy, economics, forestry, engineering, and geology (except for geomorphology) and not add experts in these fields to the soil survey staff.

16. It is recommended that field soil scientists in India be furnished more appropriate soil augers with special reference to the cylindrical types, some of which are adapted to dry soils and other types to wet soils.

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17. It is strongly recommended that the travel allowances for field scientists be increased as necessary to insure that the scientists are fully compensated for their field expenses. At the present time, the travel allowances for some field scientists are below their actual costs in the field and they must make up the difference out of their salaries. It will be impossible to attract high competent men for such work unless they are fully compensated for their field expenses. The work is more difficult than inside work and it takes men away from their families. The soil survey of India can never develop unless there are reasonable incentives for highly competent men to take up the work as a scientific career.

18. It is recommended that the administrative regulations be amended where necessary to permit reimbursement for small items of equipment obtained by scientists in the field without prior administrative approval. In carrying out field work it is often necessary to make such small expenditures; and requirements for prior approval cause unnecessary delays to the work to no purpose. The Government can be fully protected against fraud by proper post audits as needed.

(See also recommendations that follow, especially numbers 36 to 46, and appendix exhibits).

SOIL CONSERVATION

19. It is recommended that the working concept of soil conservation be broadened to include all the combinations of soil and water management practices that are needed to achieve sustained production of crops, grasses, and trees from the specific kinds of soil at the highest practical level. In every place where soil conservation is fully effective, a proper combination of four elements has been achieved: soil, water, plants, and people.

The control of soil erosion is only one aspect of soil conservation, but a very important one on certain kinds of soils. Basically, practical erosion control requires control of water, which, along with proper fertilization and other practices, gives a stabilizing productive and protective cover as much of the year as possible.

20. It is recommended that no grants for soil conservation be approved by the Soil Conservation Board until a standard soil survey of appropriate scale and detail has been made or is included in the plan for completion prior to the actual conservation planning. In the Poona area, for example, depth of soil and soil slope are the major local factors important to banding; but other very important soil differences are highly important to kinds of crops, expected yields, and other practices necessary for a conservation plan to be fully effective to the cultivator.

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21. Water control includes run-off control to allow as much water as possible to enter the soil and the remainder to flow harmlessly into prepared outlets; irrigation, drainage, or, more commonly, the two together; the conservation of the moisture in cropped soil through proper tillage and weed control; and the maintenance of productive grass cover or forests on soils too unstable or too unresponsive for cultivation. Water control is closely related to the prevention of either permanent or temporary waterlogging of soils and to the prevention or amelioration of accumulations of excess salts in the soil.

The stabilization of gulleys is a part of soil erosion control closely related to water control, to land forming to reclaim previously eroded soils, and to the establishment and guarding of useful protective trees and grasses.

Good evidence of this concept was seen in parts of India. For example, yields are increased three-fold at Sholapur by bunding and improved dry-farming methods. This has been proved in cultivators' fields. Research has shown that this yield may be doubled again by proper fertilizers being added to the combination.

The preparation of new lands or the improvement of formerly cultivated land through land clearing, irrigation, drainage, flood protection, and land forming are important parts of any national soil conservation program.

Since a soil conservation program requires research (including soil survey), education, technical assistance, cost-sharing between the government and the cultivators, credit, and stable agricultural prices, many national, state, and local agencies must cooperate together. The development of such cooperative relations should be a major function of the Soil Conservation Board and its staff.

The Soil Conservation Board should be prepared to make grants for any of these conservation measures in accordance with priorities of other public works that must be protected, the prospects of increasing agricultural production, and the prevention of loss of highly valuable agricultural soil and water.

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21. Individual village and farm planning by the cultivators is the most important aspect of soil conservation. The cultivator must take all aspects of production into account and so should all the technicians who assist him in developing a plan for his operations.

22. It is strongly recommended that every effort be taken to develop local leadership and responsibility for soil and water conservation within the villages and larger units of local government. Excellent work along this line was seen near Poona, specifically in the village of Parner. The agricultural extension officers should be asked to carry the educational program about soil conservation to the cultivators. Booklets, cinema, and posters should be prepared to show clearly the problems and what can be done. The more local leadership can be developed in soil conservation, the more will cultivators take up the work and the more enduring will be the works of improvement. The work in any catchment basin, district, or village should be developed with the local people, not simply done for them. Plans made for individual cultivators or groups of cultivators that they do not understand are not likely to be carried out effectively. But if they do understand, they will carry them out, adopt others, and continue to improve their practices. It is as important to improve the understanding of the cultivators and for them to gain confidence that they can use technical information to improve their soil, their incomes, and their ways of life as it is to get the initial works of improvement on the land. This may not be a dramatic way, but it is the most enduring way in a democratic society. For this purpose village or area associations comparable to soil conservation districts in the United States can be very helpful.

23. It is recommended that special effort and priority be given to the consolidation, or partial consolidation, of holdings in the villages, especially where run-off and erosion control are significant problems. Satisfactory schemes have already been put into effect in some villages in the D.V.C., for example. In a great many villages such adjustments are the first necessity to the design and application of those water-control measures necessary for increased and sustained production. Such measures include contour terraces on permeable soils, graded terraces on slowly permeable soils, grassed waterways, diversion terraces and gully stabilization, masonry chutes for water outlets, and so on. Unless these practices are installed and maintained full benefits cannot be expected from the use of better seeds, fertilizers, and other practices. Some cultivators do not like curving bunds; but the need must be explained to them. If straight lines are followed for bunds on curving land, the bunds will cause waterlogging or will break and cause increased erosion.

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28. 24. It is recommended that the Center arrange to inspect all
soil conservation work done by the Center or under grants of
funds to the States in order (1) to see that the work done
conforms to reasonable standards, (2) that the most improved
methods, based on adequate soil surveys are followed, (3) that
the soil conservation work is carried on cooperatively with
other village programs, (4) that villagers are given full under-
standing of the work and of their responsibility in it, and
in (5) that new and improved methods developed in the various States
are rapidly spread to all other areas in India where they apply.
Perhaps qualified soil conservationists of the Center may be at
29. regional locations for such inspections; but no administrative
"layer" should be developed between the States and the Center.

30. 25. It is recommended that no further land clearing for settlement
be approved without examination of the soil to be sure that any
potential hazard of soil erosion, soil blowing or low yields can
be controlled by the cultivators with such technical and financial
assistance as can be given.

26. It is recommended that arrangements be made, cooperatively with
the States, for continuous follow-through of soil conservation
planning in order to be sure that works of improvement are maintained
and that cultivators are given all possible assistance for further
improvement. This is especially important where large expenditures
have been made for works of improvement. For example, the new,
elevated irrigation canal near milestone 106 west of Calcutta on
the main road to Delhi is made of highly erosive material unprotected
by vegetation. Unless steps are soon taken to protect the embank-
ments, this huge investment will be lost.

27. It is recommended that all soil conservation work be carefully
integrated with soil testing, extension work, and other services
to cultivators so that the cultivators have the great benefit of
the interactions among improved water control, fertilizers, improved
seed, and the other phases of this farming operations. Only rarely
does any one of these items by itself result in great benefit: it
is the combination of all of them that gives the big improvement.

In this connection, it is further recommended that all laboratories
under the Soil Conservation Board work cooperatively with the soil
testing scheme. All soil conservation officers working with culti-
vators should be thoroughly familiar with the soil testing program
and help develop its further use by cultivators. And, of course,
those working with soil tests should explain the needs for water
control and other soil conservation measures.

24. It is recommended that the Center arrange to inspect all soil conservation work done by the Center or under grants of funds to the States in order (1) to see that the work done conforms to reasonable standards, (2) that the most improved methods, based on adequate soil surveys are followed, (3) that the soil conservation work is carried on cooperatively with other village programs, (4) that villagers are given full understanding of the work and of their responsibility in it, and (5) that new and improved methods developed in the various States are rapidly spread to all other areas in India where they apply. Perhaps qualified soil conservationists of the Center may be at regional locations for such inspections; but no administrative "layer" should be developed between the States and the Center.

25. It is recommended that no further land clearing for settlement be approved without examination of the soil to be sure that any potential hazard of soil erosion, soil blowing or low yields can be controlled by the cultivators with such technical and financial assistance as can be given.

26. It is recommended that arrangements be made, cooperatively with the States, for continuous follow-through of soil conservation planning in order to be sure that works of improvement are maintained and that cultivators are given all possible assistance for further improvement. This is especially important where large expenditures have been made for works of improvement. For example, the new, elevated irrigation canal near milestone 106 west of Calcutta on the main road to Delhi is made of highly erosive material unprotected by vegetation. Unless steps are soon taken to protect the embankments, this huge investment will be lost.

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28. It is recommended that specific arrangements be made among the Indian Council of Agricultural Research, the Soil Conservation Board, and other appropriate agencies for periodic field appraisals of the additional research needed in all phases of agriculture to make soil conservation work as efficient and effective as possible and that formal reports, including specific research needs, be fully considered in giving priority to research projects and grants. Such researches would be intended to remove any limiting factors, including improved plants, new methods of water management, livestock management, farm management, and so on.

29. Allowances for field workers who travel must be fully adequate to cover living expenses while travelling if able men are to be attracted to this work.

30. It is strongly recommended that additional study be given to the sharing of costs and risks with the cultivators who are adopting difficult soil conservation measures such as large terraces, diversions, consolidation of holdings, and the like. The inability of the cultivator to take heavy risk is often wrongly called "conservatism." Where practices are relatively new and strange to him, the State should protect his interest by guarantees or insurance against loss of income. Further, much of the need for changed practices for runoff control arises from the public need to protect streams, reservoirs, harbors, highways, towns, and other works of improvement and from the public need for food, fibre, and timber, as well as from the needs of the cultivators.

Near Ootacamund, for example, where erosion control is critical, cultivators are asked to contribute 75 percent of the cost of very expensive works, including the time of the technicians, and to pay interest on deferred payments of their share of the total cost. I strongly believe that the public share in this area should be considerably larger than 25 percent. I would suggest at least a 50-50 sharing of costs or a 60 percent share for the cultivator without considering the costs of technicians. This I regard as the minimum that is fair to the cultivators in such situations. When the costs are much lower, a 25% - 75% ratio may be appropriate, although this is a high burden to the cultivator. All India, both city and country alike, depend on agriculture and the public must bear a considerable part of the cost and share the risk in such situations.

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permeable enough to allow the extra water supplied by irrigation to pass through. As a result, temporarily high water tables develop and excess salts accumulate. Much soil that would have been highly productive with adequate drainage has been lost to agriculture. This soil-destroying process is now going on in both large and small areas in many parts of India. With proper drainage some of these soils can still be reclaimed; but others are so badly damaged that reclamation, although possible, will be laborious and costly. Certainly new projects need to be carefully studied and designed to prevent further losses.

31. It is highly recommended that a high-level group of soil scientists, engineers, and geologists, with legal assistance, study the very serious problem of soil destruction through removal of material for making bricks. Lakhs of acres of some of the best soil in India have been ruined, needlessly, by the removal of 2 or 3 feet of surface soil from large areas. This highly destructive process now goes on at an accelerated rate. Large areas in the great plain of Northern India have been so ruined. The surface soil has been removed down nearly to the water table. Salts accumulate and the soil becomes worthless for any use. Reclamation would require deep drainage ditches and reworking of the soil into raised beds.

Certainly places can be found for taking out material to far greater depths, thus disturbing much less total surface and leaving useful ponds for water storage and for fish.

It is recommended that a special technical service be developed for locating suitable places for taking material for bricks without the destruction of such vast areas of excellent soils. The good agricultural soils should be protected from destruction by appropriate use of the police power and taxing power of the State. The problem is serious because many of the soils being destroyed are among the most productive, potentially, in the world.

32. It is recommended that the attention of responsible agencies of the Center and the States be called to the damage done, unnecessarily, to wide strips on either side of many highways and canals. In many places, the surface soil has been removed from wide strips to build the grade, thus spoiling large areas of good soil. Where the water table is near the surface the soils become salty and worthless. By making deeper and narrower ditches, or borrow pits, much soil could be saved.

A suggested flow chart follows:

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33. The training of soil conservationists and soil conservation engineers in elementary soil science should be greatly strengthened. Several of the staff people interviewed consider only the characteristics of the surface soil whereas the permeability and other physical characteristics of the subsoils and substrata are even more important to water control and to the hazard of erosion. A sloping soil with a permeable surface soil, a very slowly permeable subsoil, and a soft, highly erosive substratum has an enormous erosion hazard even on gentle slopes, especially to deep U-shaped gulleying wherever water is concentrated. Level bunds on soils with slowly permeable subsoils leads to waterlogging just behind the bunds and poor crops. On such soils graded terraces to protected outlets are necessary.

These relationships need greater emphasis to both senior and junior staff at soil conservation research stations and in project areas.

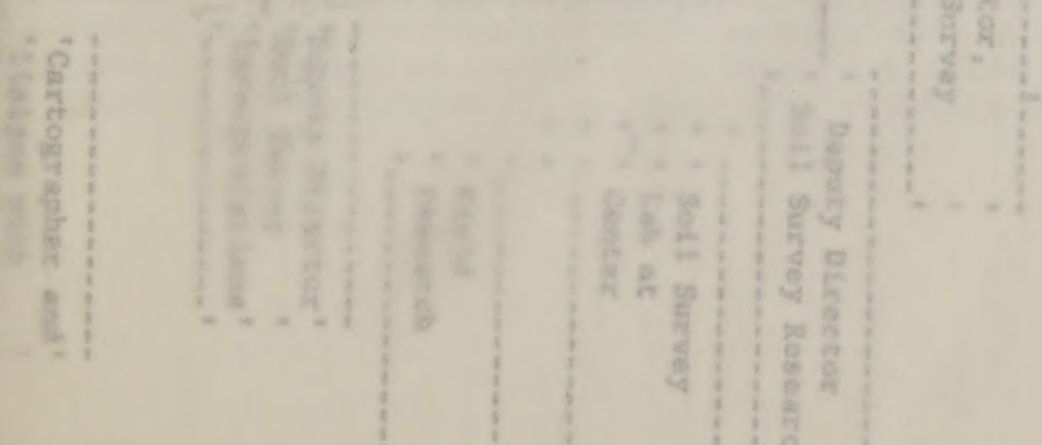
34. It is recommended that wherever possible, even at research stations, terrace construction and other earthmoving be done by bullocks rather than tractors. Tractor-made terraces will be considered wholly academic by Indian cultivators in most parts of the country for some time to come.

35. It is urgently recommended that the cooperation of State highway officials be sought for better control of water. Inadequately located and constructed ditches and culverts have resulted in enormous new gulleys in highly erosive soils. Such new gullies can be seen, for example, near Bangalore where an old undulating landscape is already being cut down by a new (geological) erosion cycle. Any concentration of flowing water is bound to bring devastating results with losses of valuable soil from cultivation.

36. It is highly recommended that the Soil Conservation Board have one top, high-ranking officer responsible for the entire program of the Center in soil conservation and soil survey. Certainly he should be someone with experience in both soil science or soil conservation and administration.

37. It is highly recommended that the Director of the Soil Survey be responsible directly to the Officer suggested in 36 above as a part of the Soil Conservation agency of the Center.

A suggested flow chart follows:



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SOIL CONSERVATION BOARD

Principal Director, Soil Conservation

Director,
Training

Director,
Agronomy

Director,
Forestry

Director,
Engineering

Director,
Soil Survey

Training
Centers

Inspection staff
to examine work
done under
grants

Research
Stations

Soil Correlator

Deputy Director
Soil Survey Research

Soil Survey
Lab at
Center

Lab

Field
force

do

Field
research

(2) Technical standards for field laboratories should be the responsibility of the Deputy Director, Soil Survey Research.

(3) As the program expands there will be need for two additional Deputy Directors of Soil Survey, one for soil correlation and one for soil survey operations.

do

Deputy Director
Soil Survey
Interpretations

(4) It is assumed that all soil survey field work will be in cooperation with States and other agencies of the Center when they have a direct interest.

(5) It is assumed that the Principal Director will develop cooperative relations with the States and all agricultural and conservation agencies of the Center.

do

Cartographer and
liaison with
Survey of India

Notes:

- (2) It is assumed that the Principal Director will develop cooperative action with States and other agencies of the Center when they have
- (4) It is assumed that all soil survey field work will be in cooperation for soil survey operations.
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- (2) Technical standards for field laboratories should be the responsibility of the Deputy Director, Soil Survey Research.
- (1) A Director of planning may be needed to work on village planning, catchment planning, and farm planning with other staff specialists.

NOTES:

Centers	Grants	done under	to examine work	Inspection staff	Stations	Research	Soil Correlator	Soil Survey Research	Deputy Director
Training									
Director	Agronomy	Director	Forestry	Director	Engineering	Director	Soil Survey	Director	

Conservation

Principal Director, Soil

SOIL CONSERVATION BOARD

Survey of India

liaison with

Cartographer and

Interpretations

Soil Survey

Deputy Director

Research

Field

Center

Lsp at

Soil Survey

38. Finally, it should be added that the attainment of efficient soil use at a high level of sustained production, which is soil conservation, depends upon a steady economic environment - stable prices, fair taxes, credit at reasonable rates, secure tenure without unreasonable rents, orderly marketing and access to the products of industry - with incentives and opportunities for the cultivators to produce, to care for the soil they cultivate, and to expand their operations as they gain skill.

TRAINING

Continued emphasis must be given to training of soil scientists for both the soil survey and for soil conservation work. It is strongly recommended that most of the training through and including the Ph.D. degree be done within India. Each of the following phases of training should be given emphasis. Perhaps the Center should have one well qualified officer whose duties include the supervision of training done by the Center and liaison with the various agricultural schools and universities.

39. In the agricultural schools that graduate diploma holders in agriculture some of the principles of soil management and conservation should be presented in ways to show how the major kinds of soil respond to different combinations of soil and water management practices. The teaching can include the recognition of the main soil characteristics, including the color, texture, structure, consistence, and moisture content of the layers of soil down to the depth (about 6 to 8 feet) that they influence plant roots and water movement; the length, shape, and degree of soil slope; and how combinations of these characteristics influence permeability, drainage, tilth, run off, erosion hazard, hazards of salt accumulations, hazards of soil blowing, hardening of the surface soil or of other layers within the soil, and so on. Examples can be explained of suitable combinations of soil and water conservation practices for different kinds of soil, including the use of fertilizers, compost, manure, improved tillage, drainage, irrigation, level and graded terraces (or bunds), crop rotations, green manures, protection of grass and trees from overgrazing and fire, and the like, along with improved seed and other agronomic and livestock management, to the end of maximizing improvement on a sustained or long term basis for agricultural production and higher incomes to the cultivators.

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42. Graduates with diplomas should be trained to describe soils, measure slopes, and perform the simple operations required in both soil survey and soil conservation planning.

40. As rapidly as possible the universities should provide B.Sc. degrees in soil science, with at least basic training in geology; geomorphology; plant physiology; chemistry; farm management (as production economics applied to soil use); and the basic principles of soil physics, soil chemistry, soil morphology, soil genesis, and classification, and soil fertility and management. Of course, it is assumed that such university students will have the basic work in language and mathematics required for these science courses. Soil science is much more than agricultural chemistry and agronomy.

During their final year, university students might be given a preference for advanced courses in soil fertility and fertilizers, soil classification, or soil and water conservation, although such specialization should not be attempted at any sacrifice of the basic courses required for a good working knowledge of general soil science.

41. It is strongly recommended that arrangements be made for at least one center for advanced training leading to the M.Sc. and Ph.D. degrees in soil science as soon as possible. Candidates should be carefully selected from among good scholars who have demonstrated industry and adaptability to field work. This requirement is important for soil scientists who may work mostly at experimental stations and in laboratories because (1) the programs of these stations should be based upon analyses of limiting factors in the agriculture of India, and (2) the results should be developed for use in the field by the cultivators themselves and by those who work with them.

At such a university, or graduate training center, arrangements should be made for candidates in soil science to work with the soil survey or soil conservation work in order to develop a thesis that is done partly in the field and partly in the laboratory (or in economics).

Advanced work along the same general lines suggested under 40 above should be available with somewhat more specialization in soil and water conservation, conservation engineering, range conservation, forest conservation, soil classification, and soil fertility and management. At least part of the students, especially those dealing with tropical soils south of the Ganges Plain should be encouraged to read French as well as English literature. (Much important work of direct value to India is published by the Office of Scientific Research in the French Overseas Ministry and in Belgium by the INEAC for the Belgian Congo).

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42. Training centers will also be needed by the Center for prospective workers in soil survey and soil conservation. As rapidly as possible, candidates recruited should be those with good academic training so that the courses at the training centers can emphasize primarily the application of technical knowledge to field problems and the necessary field skills. The courses should be designed for one six-months period.

As diploma holders are used in soil survey work, a special, intensive course of about six weeks may be needed for them.

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The success of candidates should be measured by both academic excellence and demonstrated ability for field work.

These training centers should be available to both present and prospective junior staff in both the Center and State agencies.

Those trained for soil survey work should understand the principles and techniques for recording accurately the morphology and other characteristics of soils as areas; the principles of soil classification as applied to local areas (including the concept of soil types and phases); how to interpret laboratory data; how to obtain and use data for making practical interpretations of soil surveys; how to map soils in the field; how to read aerial photographs stereoscopically; the sources and uses of available cartographic and geological maps. how to collect proper soil samples by specific soil horizons; how to distinguish among genetic soil horizons, layers inherited from the geological materials and mixtures of the two; and how to prepare handbooks for use with soil maps that describe the soils and explain their potential uses, hazards, and management requirements for high production with conservation. Such training, followed by some field work, is needed by scientists who work in the laboratories as well as by those who work mainly in the field.

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44. Immediately following this training, the men should work under supervision in the field and careful records should be kept of their ability to carry on field work that makes full use of the training they had. Arrangements should be made to correct any weaknesses immediately. From among the most successful of these men should be selected candidates for advanced academic training under fellowships. Possibly some of these may go abroad for advanced training although it would be better to have adequate facilities available in India as suggested under 40 and 41 above.

43. Some workers in soil survey and soil conservation should have opportunity for foreign training. All such candidates should have good academic records and should have demonstrated unusual industry in successful field work. For the present, some may be selected to foreign study from among those who made excellent use in the field of their previous training as outlined under 42 above. But as rapidly as advanced graduate work in soil science can be provided in India, candidates should be selected from among those who have demonstrated that they can apply their graduate training in India to the analyses of problems of Indian agriculture in the field.

46. It is recommended that a survey be made of all competent Indian soil. Besides the United States, consideration should be given to study visits abroad for soil scientists in the Netherlands (especially for wet soils), Belgium, the Belgian Congo, New Zealand, and Australia. Probably for soil conservation most would go to the United States except to the Netherlands for drainage and protection against sea flooding, to Italy and Southern France for torrent control, and to the Belgian Congo for improved natural fallow under "shifting cultivation." Of course, besides these places very good work is being done in other areas within many countries.

All such study trips should be carefully planned long in advance along definite lines with reference to specific problems and specific institutions. Plans should be made for each student to spend enough time in each place to become thoroughly acquainted with methods so that he can understand the principles behind the methods and thus understand how they may be adopted to India. Only rarely can detailed methods used successfully in one country be adopted exactly in the same way in another country. One may learn the principles of terrace construction, for example, and the terrace may be constructed by machines pulled with tractors or other machines pulled by bullocks. Rarely can soil mapping be organized and carried out in exactly the same way in two different countries having different kinds of cultivators, different kinds of technicians, different sources of transport and power, and different administrative systems. Thus, students going abroad should be able to understand principles. Most rapid study trips are nearly fruitless except for highly experienced and skilled scientists and administrators.

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Besides the United States, consideration should be given to study visits abroad for soil scientists in the Netherlands (especially for wet soils), Belgium, the Belgian Congo, New Zealand, and Australia. Probably for soil conservation most would go to the United States except to the Netherlands for drainage and protection against sea flooding, to Italy and Southern France for torrent control, and to the Belgian Congo for improved natural fallow under "shifting cultivation." Of course, besides these places very good work is being done in other areas within many countries.

All such study trips should be carefully planned long in advance along definite lines with reference to specific problems and specific institutions. Plans should be made for each student to spend enough time in each place to become thoroughly acquainted with methods so that he can understand the principles behind the methods and thus understand how they may be adopted to India. Only rarely can detailed methods used successfully in one country be adopted exactly in the same way in another country. One may learn the principles of terrace construction, for example, and the terrace may be constructed by machines pulled with tractors or other machines pulled by bullocks. Rarely can soil mapping be organized and carried out in exactly the same way in two different countries having different kinds of cultivators, different kinds of technicians, different sources of transport and power, and different administrative systems. Thus, students going abroad should be able to understand principles. Most rapid study trips are nearly fruitless except for highly experienced and skilled scientists and administrators.

44. It is recommended that all workers in the soil survey and soil conservation work be encouraged to read more widely about (a) the work at other locations than their own in India, and (b) the work on tropical soils in other countries. Many of the problems of the soils in India have already been at least partially solved in other countries on similar soils. Some additional library and bibliographical service may be necessary and somewhat more attention to the reading habits of prospective candidates for promotion.

STATUS AND RECRUITMENT

45. It is urgently recommended that the salaries of soil scientists and soil conservationists be examined with a view to any needed advancements to make them fully comparable to those of the other top scientists and administrators in the public service. Otherwise it will not be possible to attract the necessary highly competent young men in the field and the essential work will not be done.

46. It is recommended that a survey be made of all competent Indian soil scientists and soil conservationists, both within India and elsewhere, in order to recruit them to good posts in the soil survey and soil conservation program. Every one is needed now, while there is time to get agriculture going according to the obvious growing need.

47. It is strongly recommended that arrangements be made to promote young men of proved competence in field work rapidly. What a man can do is far more important to India than his previous length of service. Soil work is a relatively new field in India and industrious young men of competence and imagination who can work in the field must be attracted to the work and kept in it if any significant measure of success in agriculture improvement is to be expected.

48. As quickly as possible all positions in the Center for soil scientists and soil conservationists should be put on a permanent basis. Recruitment to temporary positions is difficult and unsatisfactory to the individuals, to the Center, and to the loaning agencies from which the men are temporarily released.

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Summary Acknowledgment

In trying to make specific recommendations, I have emphasized suggestions for consideration that I believe will lead to improvement. Many others have been made orally to staff workers. But I want to add at once that I have met several competent soil scientists and soil conservationists in India. I have seen some beginnings of soil survey work, of good research stations, and, most important, of good soil conservation work on cultivators' fields and in forest reserves. Considering the short time, I feel that I have learned a great deal that will be useful to me elsewhere.

India has a tremendous agricultural problem and tremendous agricultural potentialities. These potentialities can be realized by the combined development of industry to serve agriculture and of agriculture to serve industry. But every citizen of India should understand that the problems can be solved and the great potentialities realized only by a great deal of very hard work by many kinds of highly skilled technicians working together and with the cultivators as responsible fellow citizens.

A start has been made. It is only a start but it is encouraging. Although others have helped and can help, mainly India must find within herself the spirit, the genius, and the industry to get on with the job of developing the potential abundance in her soils, water, plants, and people. These four elements of agriculture are inseparable.

I shall be eternally grateful indeed for the great courtesy and consideration shown me by officials of all classes in India. Staff of the TCM have been most helpful. And I appreciate very much the thoughtful planning of the officials and staff of the Rockefeller Foundation who have made my study in India possible.

A list of copies of the principles for grouping soils according to soil types. THIS IS SUBJECT TO FURTHER REVIEW IN MARCH, 1954 AND IS NOT TO BE REPRODUCED.

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APPENDIX

The following exhibits about Soil Survey work in the United States were left with the Soil Survey Subcommittee:

1. Principal recent administrative memoranda (in addition to the Soil Survey Manual)
2. The Soil Survey Manual
3. Memorandum of Understanding between a State and the U.S.D.A. on soil surveys.
4. A Soil Survey Work Plan
5. An Amendment to A Soil Survey Work Plan
6. An initial review of a soil survey project
7. A folder used jointly by the University of Illinois and the Soil Conservation District for all farmer cooperators with the University or the Soil Conservation Service. Each folder contains the soil map of the specific farm and the guide sheets for the soils on the farm. On the cover is a generalized soil map of the county.
8. Sample farm maps as photographs of field sheets. As these go to farmers the soils are also labelled as to capability unit, subclass, and class.
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(S) J. Indra
April 6, 1958

The Minister for Food and Agriculture

No. 832-721/58

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PRIME MINISTER'S SECRETARIAT

Nearly two months ago, you sent me a copy of the report of Dr. Charles E. Kellogg on Soil Conservation and Soil Survey in India. His visit to India was apparently arranged through the assistance of the Rockefeller Foundation. In this report, various proposals are made. In particular, it is strongly recommended that there should be one standard soil survey to be developed cooperatively by the Centre and the States to serve all users. It was pointed out that having separate soil surveys, as now, by the Centre and the individual States, is bound to lead to unnecessary duplication, confusion in terminology and misunderstandings among both the field scientists and the users of the results.

2. It was further suggested that a memorandum be drawn up to cover the objectives and plans for cooperative soil surveys, and that this should provide for:-

1. the development of a tentative long term plan of five to ten years.
2. a firm annual plan to be developed each year, preferably at a fixed date, for the soil survey work to be undertaken, and
3. a specific work plan to be prepared for such soil survey project.

3. There are many other important suggestions in Dr. Kellogg's report. In particular, he recommends strongly that every effort be taken to develop local leadership and responsibility for soil and water conservation within the villages and larger units of local government. The work to be done in any area should be developed with the local people, not simply done for them.

4. (This paragraph concerns uniform statistical methods)

5. It seems to me that it is of great importance that there should be this uniformity in our statistics, in our soil surveys and all other data that we collect throughout the country. The Central Government and States should, therefore, accept some uniform standards and methods. I shall be grateful to know what is being done about these matters.

(Sd) J. Nehru
April 6, 1958.

To: Minister for Food and Agriculture

No. 832-PMH/58.

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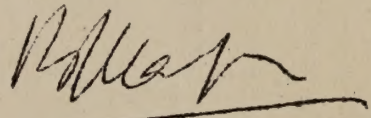
No.31-4/58 Soil Cons. (Instt)
Government of India,
Ministry of Food & Agriculture,
(Department of Agriculture)

New Delhi, dated 12th April, 1958.

O F F I C E M E M O R A N D U M .

Subject:- 5th meeting of the Standing Technical Sub-Committee for the All-India Soil and Land Use Survey Scheme held on the 28th March, 1958 in this Ministry.

The undersigned is directed to refer to the correspondence resting with this Ministry's Office Memorandum of even No. dated the 17th March, 1958 on the subject mentioned above and to forward herewith the minutes of the above meeting for information and necessary action, if any.



(B.D. Kapur)

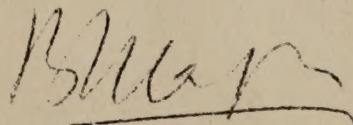
Under secretary to the Government
of India.

To

- 1-Dr.R.C. Hoon, Director (S&CM) Central Water & Power Commission.
(Flood Control), New Delhi.
- 2-The Central Silviculturist, Forest Research Institute & Colleges, Dehra Dun.
- 3-Dr.S.P. Raychaudhry, Chief Soil Survey Officer, All-India Soil and Land Use Survey, Indian Agricultural Research Institute, New Delhi.
- 4-Dr.R.R. Aggarwal, Agricultural Chemist, Govt. of U.P., Kanpur.
- 5-Dr.A.D. Desai, Deputy Director of Agriculture, Govt. of Mysore, Raichur.
- 6-Dr.T.J. Mirchandani, I.C.A.R., New Delhi.
- ✓ 7-W.M. Nixon, T.C.M., Soil Conservation Adviser and Leader, Ministry of Food and Agriculture, (Deptt. of Agriculture) New Delhi.

Copy with a copy of the minutes is forwarded to:-

- 1- P.A. to Joint Secretary (S & F)
- 2- P.A. to Deputy Secretary (D)
- 3- Agricultural Commissioner, I.C.A.R., New Delhi.
- 4- Inspector General of Forests.
- 5- Deputy Inspector General of Forests.
- 6- Director of Soil Conservation (Agriculture)
- 7- Director of Soil Conservation (Engineering)
- 8- Director of Soil Conservation (Forests).
- 9- Under Secretary (S)



(B. D. Kapur)

Under Secretary to the Government of India.

PROCEEDING OF THE 5TH MEETING OF THE STANDING TECHNICAL
SUB-COMMITTEE HELD ON 28TH MARCH, 1958 IN COMMITTEE ROOM
NO. 2 FROM 11 A.M. TO 2 P.M.

The Committee Meeting was held to discuss the Report by Dr. C.E. Kellogg for Soil Survey and Soil Conservation in India alongwith the comments of the Directors of Soil Conservation on the same.

The following were present:

1- Dr. J.K. Basu.	Chairman.
2- Shri M.S.V. Rama Rao.	Member.
3- Shri U.S. Madan.	Member.
4- Dr. S.P. Rai Choudhry	Member.
5- Dr. T.J. Mirchandani (I.C.A.R.)	Member.
6- Shri B. D. Kapur.	Under Secretary.
7- Mr. W.M. Nixon (T.C.M.)	Member.
8- Dr. Taylor	Visitor.
9- Dr. Satyanarayana	Visitor.
10- Mr. S.V. Subbaiya	Visitor.
11- Mr. H.T. Khemchandani	Visitor.

The comments of the Sub-Committee para by para are given in the Annexure I.

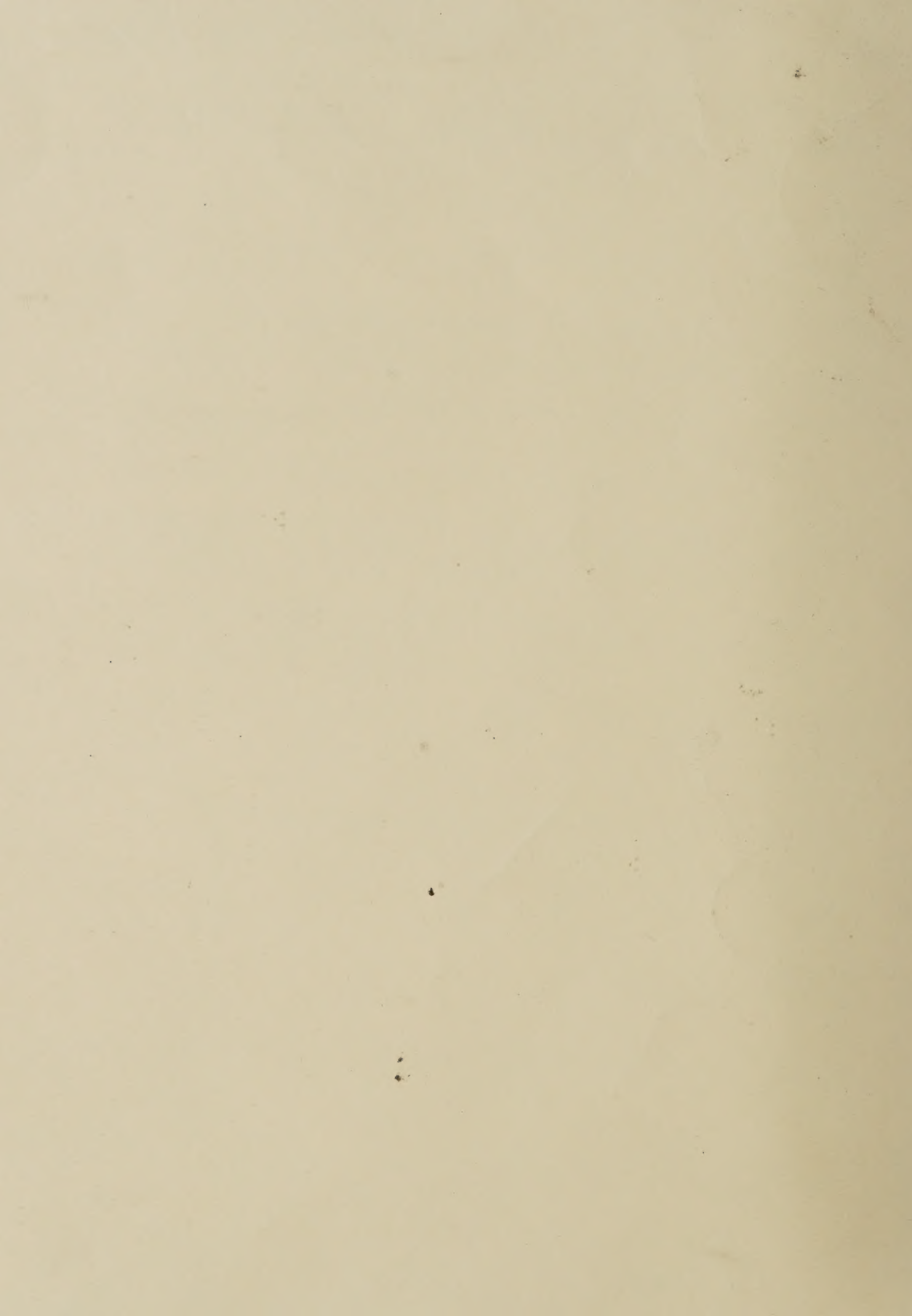
ACKNOWLEDGMENT:

The Committee acknowledged their thanks to Dr. C.E. Kellogg and Rockefeller Foundation, through whose Courtesy the visit of Dr. C.E. Kellogg was arranged. It was also suggested that sufficient number of copies of his report may be got printed for circulation.

The meeting came to a close with a vote of thanks to the Chair.

RECOMMENDATIONS OF THE TECHNICAL SUB COMMITTEE
ON THE REPORT OF DR. C. E. KELLOGG.

Para Nos. (Reference to Dr. C. E. Kellogg's Report)	Remarks of the Technical Sub-Committee	Remarks
Para 1. It is entirely feasible to develop one standard Soil Survey that can be used and understood by all. A manual of Soil Survey may have to be prepared on the lines of the U.S.D.A. Soil Survey manual to guide and help the men in the field.	Discussed at length and Dr. Ray Chaudhry agreed to have a draft Soil Survey manual within three months time.	
Para 2. In order to achieve the above object it would be necessary to draw up a memorandum of understanding between the Centre and the States and other agencies fixing the responsibilities for work between the States and the Centre.	The principle of the Memorandum of understanding was accepted and it was desired to have preliminary meeting with the State representatives and the Chief Soil Survey Officer to decide all cases so as to avoid all disputes and duplication of work in future and to have a standard survey executed to serve all purposes and thus arrive at a written understanding.	
Para 3. That all India Soil Survey should as far as possible use available village maps and supplement the same with aerial photographs (8"=1 mile) and not insist on Aerial maps for all work. It is possible to do detailed standard surveys with these village maps (16"=1 mile and 8" to 1 mile) since the average holdings here are small.	This was agreed to as most of the areas have detailed revenue maps of 16"=1 and 8"-1 mile). Aerial maps can be used in the catchments of river valleys having undulating topography or desert areas where such revenue maps do not exist. For publication of maps a scale of 2"=1 mile or 4" to a mile will serve the purpose.	
Para 4. He recommends that the extent of the all India Soil Survey should gradually expand with the trained personnel. If the area of operation exceeds the capacity of the Staff, it will result priority should be written out.	This was fully accepted.	
Para 5. Recommends that trials may be made for using diploma holders as field workers under the direction of trained Soil Scientists in order to cover as big an area as possible at as low a cost as possible.	This recommendation was accepted.	



Para Nos.	Ref. to Dr. C. E. Kellogg's Report	Remarks of the Technical Sub-Committee	Remarks
Para 6.	Impresses the need for uniformity of classification of soil, so that a uniform nomenclature is maintained throughout India. To achieve this it is better in the beginning that all the correlators should work on a project to understand the method and the nomenclature.	It was agreed to and that the correlators should actually work in two or three projects together in order to have a common understanding and uniform procedure.	
Para 7.	Recommends that the division of work should be on the basis of geographic and not on types of soil for there will be much overlap which may be avoided.	This was agreed to and the four zones were demarkated as follows :- 1. South zone whose Head Quarters will be Bangalore and it will include the following States:- (1) Kerala, (2) Mysore, (3) Madras (4) Andhra Pradesh. 2. Central Zone whose H.Qs. will be Nagpur, will include the following States :- (1) Bombay, (2) Madhya Pradesh (3) Orissa. 3. North Zone whose H.Qs. will be at Delhi (I.A.R.I.): (1) Punjab, (2) Himachal Pradesh (3) Jammu & Kashmir (4) Uttar Pradesh, (5) Rajasthan (6) Delhi. 4. Eastern Zone whose H.Qs. is Kharagpur. (1) West Bengal (2) Assam (3) Bihar (4) Tripura (5) Manipur (6) NEFA. It was further suggested that the regional division need not be taken as a rigid demarkation but can be relaxed if found necessary. The Committee felt that it may be necessary to increase the number of regions as work develops. This recommendation was accepted.	
Para 8.	Recommends that simple cartographic services be supplied at Regional Centres or at State Centres as is convenient and that the final compilation be at the same place or at the centre according to available facilities and cost.		

Para Nos.	Reference to Dr. C. E. Kellogg's Report	Remarks of the Technical Sub-Committee	Remarks
Para 9.	Recommends that arrangement be made with the Survey of India to make the colour separation plates for coloured soil maps and print all soil maps there for publication.	This recommendation was agreed to for large scale work. However, for immediate and day to day work a small number of prints can be done at the Cartographic Laboratory at I.A.R.I. where competent staff exists to do the job.	
Para 10.	Recommends that at the Centre of Soil Survey there should be a competent cartographer who should also serve as a Liaison Officer between the Survey of India and the Soil Survey work and be in a position to supply all the maps needed for the field work.	This proposal was agreed to in full.	
Para 11.	Recommends that there should be a highly qualified well trained officer knowing all the branches in the directorate for interpreting the soil maps for proper use.	The Committee suggests that to start with the Chief Soil Survey Officer should be able to undertake the work of Interpretation with the help of the three soil conservation specialists (Agronomy, Engineering and Forestry) but as the work expands, it may be necessary to have a full time officer for interpretation.	
Para 12.	Recommends that there should be highly qualified officer to supervise and carry out specific researches necessary. He should be a specialist in Morphology who should have a laboratory where research can be carried out.	Committee suggests that these experts are being undertaken by the Regional Soil Conservation Research Centres, however, soil correlation will bring observational data for new problems to research centres for further elucidation.	
Para 13.	Recommends the need for a well trained geomorphologist.	Committee agrees with the recommendation and suggest the creation of a Senior Officer and the selected man may be sent abroad for proper training.	
Para 14.	Recommends that priority of surveys must be fixed and the work started on a small area to start with before vast areas are taken up.	Priority was fixed for doing the survey work within the major River catchment areas and the order will be; (1) Bakra Mangal, (2) Hirakud and (3) Kosi Project.	
Para 15.	Recommends that there is no need for the soil survey to have a specialist in Agronomy, Engineering and Forestry but establishment cooperative relationships with existing agencies.	The integrated soil survey has already made provision for their specialists to help the Chief Soil Survey Officer in the work of interpretation and also in the preparation of detailed land plans. But in the case of Economics and Geology cooperative relationship will be established with the appropriate agencies.	

Para Nos.	Ref. to Dr. C. E. Kellogg's Report	Remarks of the Technical Sub-Committee	Remarks
Paras 16 and 17.	Recommends that field soil scientists in India be provided with appropriate tools such as soil augers, etc.	This was agreed to.	
Paras 17 and 18.	Recommends appropriate subsistence allowance for field staff.	Committee agreed with Dr. Kellogg and felt that adequate field allowance may be given to compensate for the additional expenditure that the field survey staff will be incurring. Suggested that the Chief Soil Survey Officer should therefore send suitable proposals to the Director I.A.R.I. with precedents of such practices prevailing in other Ministries.	
Para 19.	Explains that Soil Conservation practices should be comprehensive and include all aspects of soil and not confine to erosion prevention alone and as such recommends that Centre should give help for all of these measures which are conducive to greater production.	The Committee agreed in full the recommendations of the Director in the matter.	
Para 20.	Recommends that no grants be sanctioned by the Central Soil Conservation Board until a Standard Survey of the appropriate scale has been carried out.	The suggestions made are very appropriate and should be implemented as rapidly as possible.	
Para 21.	Stresses the importance of the participation of the cultivators and the villagers for work in that village.	These suggestions are very appropriate and should be implemented as early as possible.	
Para 22.	Recommends that every effort should be made to develop local leadership and responsibility for the type of work.	---- do ---	
Para 23.	Recommends that special effort and priority be given to consolidation of holdings or partial consolidation of holdings in the villages particularly where run-off and erosion control are significant problems.	---- do ----	

Para Nos.	Reference to Dr. C. E. Kellogg's Report	Comments of the Technical Sub-Committee	Remarks
Para 24.	Recommends that the Centre arranges to inspect all Soil Conservation work done in the States carried out by the grants given.	Committee feels that this is a very important suggestion and the Board is already considering how this can be done in the best possible way. The appointment of Liaison Officers at certain places has been the first step but this does not appear to be sufficient. The transport Ministry have already established regional offices with sufficient powers to improve the tempo of progress of work on highways. Sooner or later we may have this formation in order to see that the work of soil conservation is implemented to the extent that is assigned under the definition of soil conservation including proper use of funds allotted for the purpose.	
Para 25.	Recommends that no further land clearing be done without previous examination of the soil in the area with regard to Hazard and suitability for crops.	Recommended that this aspect should be brought to the notice of the Rehabilitation Ministry who are sponsoring such schemes for rehabilitating refugees from East Pakistan.	
Para 26.	Recommends that arrangements be made co-operatively with the State Governments for continuous follow-ups of soil conservation measures.	Committee recommends that this should be brought to the notice of the State Governments and particularly the instance quoted, to the Damodar Valley Corporation.	

.....Contd.....6.

Para No.	Reference to Dr. C.E. Kellogg's report.	Comments of the Technical Sub-Committee.	REMARKS.
27	Recommends that all soil conservation work be integrated with the other organisation so as to have the full support of the cultivators and farmers.	Committee feels that this recommendation be sent to the Extension Wing of the Ministry of Food & Agriculture and to the Ministry of Community Projects for their consideration.	
28	Recommends that there should be co-ordination between other activities relating to Agriculture such as I.C.A.R. etc. so that additional research work if needed may be carried out and give priority to research projects and furnish grants.	This recommendation is particularly met with by the Central Soil Conservation Board by holding yearly Seminars where research workers and Extension workers are brought together to discuss each others problems. It is recommended that the Directors of the Central Soil Conservation Board be represented on the relevant Committee under I.C.A.R. & Forestry to press the requirements of soil conservation in their projects.	
29	Recommends proper allowances to field workers to meet the actual expenses.	Already recommended under paras 17-18.	
30	Strongly recommends that the State should share the cost and risks when the former is asked to carry out new and costly improvement.	Committee is also of the same opinion and in cases where the cost is more such as terracing which cost Rs.400/- per acre the State should be able to share 50% of the cost (the Centre and State sharing 25% of the cost each).	
30-A	Recommends that more attention should be paid to drainage as he finds no attention has been paid to the irrigated areas.	Agrees with the recommendation and proposes to refer such cases to Irrigation Departments concerned and recommends that in the new areas the drainage should be included as part of Irrigation Schemes.	
31	Recommends that a suitable high level body consisting of Soil Scientists, Engineers and Geologists be created to study the serious problems of soil destruction through the removal of top soil for the manufacturing of bricks in almost all the North India plains.	Committee agrees that this is a serious menace particularly nearer towns and must be brought to the notice of the authorities who issue licenses and the State Governments should consult technicians before issuing licences.	

Para No.	Reference to Dr. C.B. Kellogg's report.	Comments of the Technical Sub-Committee.	REMARKS.
Para 32	Brings the prevailing practice of damage done on either sides of road and canals for building of roads by cutting wide strips of good soil.	Recommends that this should be brought to the notice of the concerned authorities in the several States.	
Para 33	Says that the subject of soil science is not properly understood and as such importance should be given to the study of soil science both at lower and higher level.	proper importance is given in the training we are giving to the soil conservation trainees.	
Para 34	Recommends the use of bullocks instead of tractors for making terraces and bunds for something to do, even in Research Stations.	Agrees with the recommendation to use bullocks power with suitable tools. But in areas where labour is costly we may have to revert to tractors which may have to be imported.	
Para 35	Attention of the high-way officials should be drawn to the damages done to the road sides at various places due to improperly located culverts and ditches resulting in deep gullies.	Fully agrees with the recommendation.	
Para 36	Recommends that there should be a Chief in the Central Soil Conservation Board and be responsible for the entire programme.	This may be considered by the Administration.	
Para 37	Recommends that the Chief Soil Survey Officer should be under the administrative control of the Chief of Soil Conservation.	As this is an Administrative matter and depend upon para 36, it was not considered in the Committee.	
Para 38	Training in Soil Conservation even Ph.D. Degree should be given within the country. Suggests the Centre should have a well qualified officer to supervise training given by the Centres and the States.	The Committee felt that this aspect may be considered by the Economics and Statistical Directorate for taking suitable action.	
Para 39	Generally says that sustained effort on all aspect should result in better out put of Farm yield.	Accept the suggestion.	

No.	Reference to Dr. C.E. Kellogg's Report.	Remarks of the Technical Sub-Committee	REMARKS.
39	Recommends that proper training emphasising the importance of soil and its management should be imparted to the student in colleges and diploma schools etc.	The Agricultural personnel committee appointed by the Government of India have recommended that Soil Cons. as a subject in the agricultural and forest institutes should be started from the 3rd 5 years plan. Recommends that this extract may be sent to the Ministry of Education as well as to the State Governments to take suitable steps.	
40	Recommends that the Indian Universities should start Soil Science teaching to B.Sc. degree as soon as possible.		
41	Recommends that arrangements should be made as soon as possible to train men for M.Sc. and Ph.D. in Soil Science at least in one Centre.	Agrees with the recommendation and has been in practice in some Universities. However, it is worth while sending this extract to the Ministry of Education.	
42	Recommend establishing training centres for Soil Conservation work both at the Centre and the States so that proper qualified men will be available for the service.	Government of India have already established training Centres both for officers and assistants for their training in Soil Cons. which includes Soil Survey also. The recommendation of six weeks course in Soil Survey for diploma holders will be considered in due course. (2) When the No. of training institutes increase the question of a special officer will be considered. The suggestion contained in the last but one sub. para will be taken into account while preparing the syllabus for the soil survey course.	
43	Some workers in Soil Survey and Soil Conservation should have opportunity for foreign training.		

Para No.	Reference to Dr. C.E. Kellogg's Report.	Remarks of the Technical Sub-Committee.	REMARKS.
<u>Para 44</u>	Recommends that all workers in Soil Survey and Soil Cons. should be given ample opportunities to read more widely about work done on similar tropical soil as many States have done some work on similar soils.	This is a very good suggestion and may be brought to the notice of all workers in this field of Soil Conservation and Survey in India.	
<u>Para 45</u>	Recommends that attractive salaries be paid to the Soil Scientists & Conservationists to attract top men to the service.	Agrees that this is an important recommendation of far reaching effect on the future of the service and the work in the country.	
<u>Para 46</u>	Recommends that a survey be made of all Soil Scientist and Conservationist in the country and elsewhere so that when time comes they may be recruited to suitable high posts.	It is presumed that the Education Ministry and the Planning Commission are collecting such information within the country and hence their suggestions may be brought to their notice for further necessary action.	
<u>Para 47</u>	Recommends that work in the field should be given preference to length of service when promotions are considered.	These recommendations are considered to be very important and will have far reaching effect on achieving the targets of Soil Conservation in the country in particular and advancement of agriculture in general.	
<u>Para 48</u>	Recommends that all the posts in the Centre should be put under permanent basis as soon as possible.		

